

An Ecological Approach to Investigating the Influences of Obesity

by

Brandy-Joe Milliron

A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

ARIZONA STATE UNIVERSITY

August 2010

An Ecological Approach to Investigating the Influences of Obesity

by

Brandy-Joe Milliron

has been approved

June 2010

Graduate Supervisory Committee:

Kathleen Woolf, Chair

Linda A Vaughan

Barbara Ainsworth

Chris Wharton

Cheryl Der Ananian

Bradley Appelhans

ACCEPTED BY THE GRADUATE COLLEGE

ABSTRACT

"Globesity," as defined by the World Health Organization, describes obesity as a pandemic affecting at least 400 million people worldwide. The prevalence of obesity is higher among women than men; and in non-Hispanic black and Hispanic populations. Obesity has been significantly associated with increased all-cause mortality, and mortality from cardiovascular disease, obesity-related cancers, diabetes and kidney disease. Current strategies to curb obesity rates often use an ecological approach, suggesting three main factors: biological, behavioral, and environmental. This approach was used to develop four studies of obesity. The first study assessed dietary quality, using the Healthy Eating Index (HEI)-2005, among premenopausal Hispanic and non-Hispanic white women, and found that Hispanic women had lower total HEI-2005 scores, and lower scores for total vegetables, dark green and orange vegetables and legumes, and sodium. Markers of obesity were negatively correlated with total HEI-2005 scores. The second study examined the relationship between reported screen time and markers of obesity among premenopausal women and found that total screen time, TV, and computer use were positively associated with markers of obesity. Waist/height ratio, fat mass index, and leptin concentrations were significantly lower among those who reported the lowest screen time versus the moderate and high screen time categories. The third study examined the relationship between screen time and dietary intake and found no significant differences in absolute dietary intake by screen time category. The fourth study was designed to test a brief face-to-face healthy shopping intervention to determine

whether food purchases of participants who received the intervention differed from those in the control group; and whether purchases differed by socioeconomic position.

Participants in the intervention group purchased more servings of fruit when compared to the control group. High-income participants purchased more servings of dark green/deep yellow vegetables compared to those in the low-income group. Among those who received the intervention, low-income participants purchased foods of lower energy density, and middle-income participants purchased food of higher fat density. The findings of these studies support policy changes to address increasing access and availability of fruits and vegetables, and support guidelines to limit screen time among adults.

DEDICATION

For Kathleen, my mother, and father.

ACKNOWLEDGMENTS

This Dissertation research would never had been possible if not for the help of the following people:

Dr. Kathleen Woolf, Elisha Daigneault, Catherine Jarrett, Jenna Heller, Barbara Ruhs, Dr. Brad Appelhans, Megan Grimstedt, Brooke Bjorge, Shauna Salvesen, Mark Johnson, Mallory Adams, Kristina Buchman, Kristin Smith, Amanda Palich, and Michelle Cauwels.

TABLE OF CONTENTS

	Page
LIST OF TABLES.....	xii
CHAPTER	
1 AN ECOLOGICAL APPROACH TO THE OBESITY PANDEMIC: A BRIEF REVIEW OF THE LITERATURE	1
Estimates of deaths associated with obesity	2
Direct and indirect costs associated with obesity	4
Ecological approach.....	5
Dietary quality	7
Screen time (television and computer use)	12
Food purchasing behavior	20
References.....	27
2 LOWER DIETARY QUALITY IN YOUNG HISPANIC WOMEN IN THE SOUTHWESTERN UNITED STATES.....	35
Abstract	35
Introduction.....	36
Objective	40
Methods.....	40
Results	45
Discussion	46

Conclusion	53
References	59
3 THE POSITIVE RELATIONSHIP BETWEEN SCREEN TIME (TV, COMPUTER) AND MARKERS OF OBESITY IN WOMEN.....	64
Abstract	64
Introduction.....	65
Methods.....	69
Results	75
Discussion	77
Conclusion	82
References	89
4 DIETARY INTAKE DURING SCREEN TIME AMONG PREMENOPAUSAL WOMEN.....	93
Abstract	93
Introduction.....	95
Methods.....	99
Results	103
Discussion	105
Conclusion	111

References	118
5 EFFECTS OF A HEALTHY SHOPPING INTERVENTION AND ANNUAL HOUSEHOLD INCOME ON SHOPPING BASKET NUTRIENT CONTENT: A RANDOMIZED CONTROLLED TRIAL	122
Abstract	122
Introduction	124
Methods	131
Results	136
Discussion	139
Conclusion	142
References	150
6 CONCLUSION	154
REFERENCES	158
APPENDIX	
A CHAPTER 2 IRB APPROVAL, CONSENT FORM, AND STUDY QUESTIONNAIRES	
B CHAPTERS 3 AND 4 IRB APPROVAL, CONSENT FORM, AND STUDY QUESTIONNAIRES	
C CHAPTER 5 IRB APPROVAL, CONSENT FORM, AND STUDY QUESTIONNAIRES	

LIST OF TABLES

Table	Page
1. Descriptive Characteristics of Hispanic and Non-Hispanic White Women	55
2. Reported Energy and Macronutrient Intake of Hispanic and Non-Hispanic White Women	56
3. Healthy Eating Index-2005 Scores for Hispanic and Non-Hispanic White Women	57
4. Pearson Product-Moment Correlations Between Total Healthy Eating Index 2005 Score and Markers of Obesity	58
5. Characteristics of the Study Population as Categorized by Body Mass Index	83
6. Pearson Product-Moment Correlations and Partial Correlations Between Total Screen Time and Markers of Obesity	85
7. Pearson Product-Moment Correlations and Partial Correlations Between Television Viewing and Computer Use and Markers of Obesity	86
8. Markers of Obesity as Categorized by Total Screen Time (Television and Computer Use) Using Physical Activity (min/day) as a Covariate	87
9. Characteristics of the Study Population as Categorized by Screen Time (Television and Computer Use)	113
10. Total Dietary Intake as Categorized by Screen Time (Television and Computer Use)	114
11. Percent of Dietary Intake Consumed During Total Screen Time (Television and Computer Use)	115

12.	Dietary Intake Consumed During Television Viewing and Computer Use	117
	Table	Page
13.	Descriptive Characteristics According To Shopping Intervention Group	144
14.	Nutrient Profile of Food Purchases According to Shopping Intervention Group	145
15.	Nutrient Profile of Food Purchases According to Income (Percent Federal Poverty Line) and Intervention Group	146
16.	Analysis of Variance Comparing Food Purchases by Income Level (Percent Federal Poverty Line) and Intervention Group	148

Chapter 1

An Ecological Approach To The Obesity Pandemic:

A Brief Examination of Dietary Quality, Screen Time, and Food Purchasing Behavior

Introduction

Overweight and obesity are defined as an excess of body fat accumulation that increases an individual's risk for chronic disease [World Health Organization (WHO), 2006]. The calculation of body mass index (BMI; kg/m^2) is a crude population measure commonly used to categorize an individual into a weight group. Using this measure, normal weight BMI is defined as 18.5-24.9 kg/m^2 , while a BMI of 25.0-29.9 kg/m^2 represents overweight status and a BMI of ≥ 30.0 kg/m^2 classifies an individual as obese. The National Institutes of Health further categorizes obesity into three classes: class 1, BMI 30.0-34.9 kg/m^2 ; class 2, BMI 35.0-39.9 kg/m^2 ; class 3, BMI ≥ 40.0 kg/m^2 [National Institutes of Health (NIH), 1998]. Epidemiological studies often collapse the obesity classes into two categories: obesity (BMI 30.0-39.9 kg/m^2) and extreme obesity (BMI ≥ 40.0 kg/m^2).

“Globesity,” as defined by the World Health Organization, describes obesity as a pandemic, affecting at least 400 million people worldwide (WHO, 2005). As the term suggests, the high prevalence of obesity is not limited to high-income countries, but is now dramatically increasing in low- and middle-income countries. Specifically, parts of Eastern Europe, China, the Pacific Islands, and the Middle East report alarming increases in obesity (WHO, 2001). The WHO projects that the prevalence of obesity may reach 700 million adults worldwide by 2015.

Demographic trends associated with obesity

In the United States (US), obesity varies by sex, race/ethnicity, age, and geographic location (Flegal, Carroll, Ogden, & Curtin, 2010; Ogden, Yanovski, Carroll, & Flegal, 2007) [National Center for Chronic Disease Prevention and Health Promotion (CDC), 2010]. In 2007-2008, the age-adjusted prevalence of obesity in the US was 33.8% (Flegal et al., 2010). A higher obesity prevalence was observed among women (35.5%) when compared to men (32.2%). For women and men, the same obesity prevalence trends by race/ethnicity (age adjusted) are observed with the highest prevalence among non-Hispanic black (44.1%) and Hispanic (38.7%) populations, and lower prevalence among non-Hispanic whites (32.4%).

When considering sex, race/ethnicity, and age, non-Hispanic white men over the age of 60 (38.4%) have the highest prevalence of obesity, while men between 40-59 years have the highest prevalence of obesity among non-Hispanic black (39.7) and Mexican-American (38.2) men (Flegal et al., 2010). Among women, those between 40 and 59 years of age have the highest prevalence of obesity, regardless of race/ethnicity. Obesity trends among US adults by state show that South Carolina, Oklahoma, Tennessee, West Virginia, Alabama, and Mississippi have obesity rates that are greater than 30%, while Colorado, Massachusetts, Rhode Island, and the District of Columbia have prevalence rates of less than 22% (CDC, 2010).

Estimates of deaths associated with obesity

The National Health and Nutrition Examination Survey (NHANES) aims to assess the health and nutritional status of adults and children in the US [CDC, National Center for Health Statistics (NCHS), 2010], and combines both interviews and physical examinations. The interviews provide demographic, socioeconomic, dietary, and other health-related information, while the physical examinations include medical, dental, physiological, and biochemical information. Relevant measurements of body size and composition include BMI, percentage of fat assessed by bioelectrical impedance analysis (BIA), skinfold thicknesses, and waist, hip, and arm circumferences.

Using NHANES data, Flegal et al. (2007) evaluated the relationship between BMI and cause-specific excess deaths using data from NHANES I, II, III, and NHANES 1999-2002, and 2004 vital statistics data from 2004 US total mortality. The main outcome measures included cause-specific excess deaths in 2004 by BMI levels for categories of cardiovascular disease (CVD), cancer, and all other causes. Cancer was subdivided into three groups: deaths from lung cancer, deaths from obesity-related cancers (colon, breast, esophageal, uterine, ovarian, kidney, and pancreatic cancer), and deaths from all other cancers. Their findings suggest that obesity was associated with significantly increased CVD mortality and increased mortality from cancers considered obesity-related. Overweight and obesity combined were associated with increased mortality from diabetes and kidney disease.

In their 2005 analysis, Flegal et al. (2005) reported a significant positive association between all-cause mortality and obesity. Obesity was associated with significantly increased CVD mortality, which primarily drove the association between

increased all-cause mortality and obesity. Obesity was also significantly associated with 11% of deaths from obesity-related cancers, as well as increased mortality from diabetes and kidney disease.

Direct and indirect costs associated with obesity

Economic and technologic advances have made it easier and more economical to (1) consume high-energy- low-nutrient dense foods in greater portions, and (2) avoid physical activity during daily living, leading to dramatic increases in obesity. While the health risks associated with obesity are experienced by the obese individual, the costs of treatment are shared. In 2002, the direct (i.e., preventive, diagnostic, and treatment services such as personal health care, physician visits, hospital care, and medications) and indirect (i.e., costs resulting from reduction or cessation in productivity due to disease such as lost wages and lost future earnings) medical costs of obesity in the US were estimated as more than \$92 billion (Ogden, 2007). The cost of obesity treatment, such as weight loss programs and products, was estimated as more than \$30 billion.

For the US population, 5.3% of medical spending was attributed to obesity alone (Finkelstein, Fiebelkorn, & Wang, 2003). In 2005, Anderson et al. (2005) estimated the proportion of total health care charges associated with physical inactivity, overweight, and obesity, and reported associated charges at the health plan and the national population level among US populations aged 40 years and older. The analysis consisted of data retrieved through a healthplan and was composed of a random sample of 8000 individuals. Independent variables, such as physical activity, height, and weight, were self-reported. Anderson et al. (2005) reported a significant association between health

behaviors and health care charges and suggested that physical inactivity, overweight, and obesity accounted for 23% of the health plan's charges and 27% of national charges. The charges associated with the selected risk factors were highest among the oldest age group (aged 65 years and older) and for individuals with chronic conditions, however, nearly half of the charges were generated from individuals between 40 and 64 years of age.

Ecological approach

Current strategies used to curb obesity rates are more often using an ecological approach, as opposed to the traditional view of obesity as a personal disorder that requires treatment (Egger & Swinburn, 1997). In effort to prevent obesity on a global scale, the International Obesity Task Force (Kumanyika, Jeffery, Morabia, Ritenbaugh, and Antipatis, 2010) developed a comprehensive ecological model, highlighting the importance of this approach. The ecological approach to the obesity pandemic suggests three main influences on equilibrium levels of body fat: biological, behavioral, and environmental. Biological influences encompass unalterable factors such as age, sex, hormones, and genetics (Katahn & McMinn, 1990). Behavioral influences include habits, emotions, attitudes, beliefs, and cognitions (Brownell & Wadden, 1992). The environmental component of the ecological approach is divided into two settings (Egger & Swinburn, 1997). The microenvironment describes the setting in which the behavior takes place, such as the local gym or supermarket (Booth et al., 2001). The macroenvironment describes additional factors, such as the fitness industry or food service industry, that influence behavior settings directly or indirectly (Booth et al., 2001; Egger & Swinburn, 1997). In addition to the independent effects of these three main

influences, multiple factors intersect, impacting the obesogenic environment and the individual. For example, biological and environmental factors affect behavior; and the intersection of behavior and the environment can exacerbate the phenotypic expression of a genetic propensity toward obesity.

The ecological model proposed by Egger and Swinburn (1997) uses total energy as a mediator. The paradigm for understanding obesity in this perspective suggests that the equilibrium of fat stores depends on energy intake and energy expenditure (mediators), and is adjusted for physiological factors, referring to metabolic and behavioral changes that follow an interruption in energy balance equilibrium (Egger & Swinburn, 1997). Physiological adjustments (metabolic and behavioral) occur in an attempt to minimize large fluctuations in body weight. For example, in response to positive energy balance, hypophagia should occur as a result of small increases in leptin concentrations and gut factors such as cholecystokinin (among other chemicals) (Milewicz, Mikulski, & Bidzinska, 2000). These hormones generate signals to the brain to reduce intake. Small increases in energy expenditure may also be observed to help the body maintain metabolic homeostasis (Leibel, Rosenbaum, & Hirsch, 1995).

Given that the mediators in this ecological model include energy intake and expenditure, each of the datasets described in this dissertation address dietary intake, and three of the four manuscripts developed from the data address dietary intake as a central theme. One of the three datasets addresses sedentary behaviors, and two manuscripts developed from this dataset examine sedentary behavior as a central theme. The remainder of this introduction will describe how each chapter approached obesity using

an ecological perspective. Although the manuscripts do not address each component of the ecological model, this perspective was used when developing the studies.

Dietary quality

Aligned with the ecological perspective described by Egger and Swinburn (1997), biological and behavioral factors influence obesity and can help describe the different prevalence rates observed among populations. As previously noted, a higher prevalence of obesity was reported among women (35.5%) when compared to men (33.8%) (Flegal et al., 2010). Women 40-59 years of age, regardless of race/ethnicity, have the highest reported rates of obesity as well. Possibly reflecting differences in cultural beliefs and practices (behavior), Hispanic women (38.7%) have a higher prevalence of obesity when compared to non-Hispanic white women (32.4%). Therefore, a study was designed to assess dietary quality among premenopausal Hispanic and non-Hispanic white women in Arizona. The secondary objective of the study was to examine the relationship between dietary quality and markers of obesity [waist circumference, total percent body fat, percent trunk fat, and body mass index (BMI)]. Premenopausal women were chosen as the study population to minimize confounding biological factors associated with menopause that might influence adiposity.

Dietary patterns and race/ethnicity. Clear differences exist in the prevalence of obesity among Hispanic and Non-Hispanic white women in the US. However, trends in contributing factors are less clear in the literature. Using a computerized interviewer-administered diet history questionnaire, Murtaugh et al. (2007) conducted a cross-sectional study to describe common dietary patterns followed by Hispanic and non-

Hispanic white women living in the Southwestern US. They also examined whether dietary composition was associated with overweight and obesity. Compared with non-Hispanic white women, Hispanic women reported consuming more energy, a greater proportion of energy from fat and vegetable protein, less alcohol, and less energy from animal protein. Higher proportions of energy from total protein and animal protein were associated with a greater risk of overweight. Among non-Hispanic white women, greater proportions of energy from fat and animal protein were associated with a higher risk of obesity.

Using a food frequency questionnaire (FFQ) and a fat-related dietary habits questionnaire, Kristal et al. (1997) compared nutrient and food group consumption among non-Hispanic white, black, and Hispanic women. There were no differences in nutrient intake across race/ethnic groups. Regardless of race/ethnicity, the largest source of fat was from added fats, however, more added fats were consumed among white women. Hispanic women reported consuming more fat from dairy products, fried vegetables, and salad dressing; and black women reported consuming more fat from poultry. Hence, there appear to be subtle dietary patterns by race/ethnicity, however, a more healthful pattern was not identified.

Hispanic and Latino populations report consuming more fruits and vegetables when compared to non-Hispanic white and black populations (Neuhouser, Thompson, Coronado, & Solomon, 2004; Thompson et al., 2005). Neuhouser et al. (2004) compared dietary intake among Hispanic and non-Hispanic white participants in Washington state. Hispanic participants reported consuming one more serving of fruits and vegetables when

compared to non-Hispanic white participants. A limitation in this study was that dietary intake was determined using a six-item FFQ. Similarly, Thompson et al. (2005) also used a FFQ and found that fruit, vegetable, and fiber intake was highest among Latino men and women when compared to non-Latino whites and non-Latino blacks.

Dietary quality indices. When comparing dietary intake among subpopulations, inconsistencies occur in outcome measures, hence making it challenging to compare findings. Dietary intake surveys and questionnaires phrase questions differently and estimations of servings vary by participant. To help minimize this constraint, researchers in the US have developed several methods to measure dietary quality by assessing the consumption of food types and groups (as opposed to individual nutrients). Assessment of dietary quality investigates dietary behavior by measuring compliance with national dietary guidelines and is determined by scoring food patterns. Assessment of dietary quality can also indicate how diverse the variety of health choices are within core food groups, help researchers monitor change in the diets of US populations, and help promote healthier behaviors (Basiotis, Carlson, Gerrior, Juan, Lino, 2002; Guenther, Juan, Reedy J., et al., 2008; Wirt & Collins, 2009). Both protective and unfavorable dietary patterns can be identified.

A review that described current dietary quality tools and their applications identified seven major indices: the Healthy Eating Index (HEI) (Guenther, Reedy, & Krebs-Smith, 2008; Hann, Rock, King, & Drewnowski, 2001), the Healthy Diet Indicator (HDI) (Huijbregts et al., 1997), the Healthy Food Index (HFI) (Osler, Heitmann, Hoidrup, Jorgensen, & Schroll, 2001), the Recommended Food Score (RFS) (Kant,

Schatzkin, Graubard, & Schairer, 2000), the Diet Quality Index (DQI) (Seymour et al., 2003), the Diet Quality Score (DQS) (Fitzgerald, Dewar, & Veugelers, 2002), and the Mediterranean Diet Score (MDS) (Trichopoulou et al., 1995; Wirt & Collins, 2009). Most indices of dietary quality, such as the HEI and DQI, are based on both food groups and nutrients. There are a few indices, such as the HFI, that are based on food groups. Common food components include vegetables, fruits, grains, meat products, dairy products, and oils. Common nutrient components include total fat, saturated fat, and cholesterol (Wirt & Collins, 2009). In addition to food groups and specific nutrients, dietary variety is also used in some indices. In their review, Wirt and Collins (2009) reported that diet quality scores were usually inversely related to health outcomes. Studies supporting the inverse association reported that all-cause mortality was reduced by 17-42%, cardiovascular disease (CVD) mortality by 18-53%, CVD risk by 14-28%, cancer mortality by 13-30%, and all-cause cancer risk by 7-35% (Wirt & Collins, 2009).

Healthy Eating Index-2005. One of the most well-known dietary quality indices is the HEI, created by researchers at the US Department of Agriculture (USDA) Center for Nutrition Policy and Promotion (CNPP). The HEI is a single, summary measure of dietary quality based on nutrients and foods and assesses adherence to the US Food Guide Pyramid and Dietary Guidelines for Americans (Hann et al., 2001). The original HEI was revised to reflect the 2005 Dietary Guidelines for Americans. The HEI-2005 places emphasis on characteristics of dietary quality, such as whole grains, various types of vegetables, specific types of fats, and discretionary calories (or the calories from solid fat, alcohol, and sugar) (Guenther et al., 2008). The HEI-2005 components include total

fruit (cups), whole fruit (excluding juice) (cups), total vegetables (cups), dark green and orange vegetables and legumes (cups), total grains (oz), whole grains (oz), milk (cups), meat and beans (oz), oils (g), saturated fat (percent energy), sodium (g), and calories from solid fat, alcohol, and added sugar (percent energy). The HEI-2005 scoring is based on a density approach, expressed per 1,000 kcal. Therefore, variation in energy intake does not interfere with the diet quality outcome. The total score is the sum of 12 component scores, and a higher total HEI-2005 score reflects greater dietary quality (maximum 100).

Dietary quality and health. Supporting an ecological approach, the quantity, quality, and diversity of dietary intake often varies by age, race/ethnicity, socioeconomic factors, acculturation, and health status (Ford, Will, De Proost Ford, & Mokdad, 1998). Dietary quality may also differ by lifestyle factors such as smoking, alcohol consumption, and engagement in physical activity (Guo, Warden, Paeratakul, & Bray, 2004; McCullough et al., 2002). Several studies have reported a correlation between dietary quality and obesity and chronic disease risk (Ervin, 2008; Gao et al., 2008; Hann et al., 2001; McCullough et al., 2002; Newby, Muller, Hallfrisch, Andres, & Tucker, 2004). Because the assessment of dietary quality is fairly new, research needs to continue investigating the relationship between dietary quality, population demographics, and obesity and chronic disease.

Screen time (television and computer use)

As previously mentioned, an ecological approach to addressing obesity suggests that biological, behavioral, and environmental factors influence levels of body fat (Egger & Swinburn, 1997). This perspective also aims to understand health behavior by focusing

on the nature of people's transactions with their sociocultural and physical surroundings (Stokols, 1992). The microenvironment in this model encompasses factors that are within close proximity to the individual, and can include screen time (television watching and computer use) (Egger & Swinburn, 1997). Television viewing is a highly prevalent sedentary behavior among adults in the US as the average household spends over eight hours per day watching television (Nielsen Media Research, 2007). Further, computer usage among adults has dramatically risen (Kominski & Newburger, 1999). With this in mind, a study was developed that focused on screen time as an environmental and behavioral influence of obesity.

Two manuscripts were developed from the screen time data. The first (Chapter 3) manuscript examined the relationship between reported screen time (television and computer time) and markers of obesity [body mass index (kg/m^2 ; BMI), waist/height ratio (WHtR), total body fat (percent), fat mass index (kg/m^2 ; FMI), trunk fat /leg fat, and serum leptin concentrations (ng/ml)] among young, premenopausal women. This analysis included self-reported physical activity (min/day) as a covariate to investigate the independent effect of screen time on markers of obesity. The second manuscript from the screen time data (Chapter 4) examined the relationship between screen time and dietary intake in the same sample of women. Dietary intake was categorized in terms of total daily dietary intake (snacks, energy, fat, saturated fat, sugar, fiber, calcium, and vitamin C), and the proportion of intake consumed during total screen time, television only, and computer use only.

Physical activity recommendations. The Centers for Disease Control and Prevention (2009) recommend achieving at least 150 minutes of moderate-intensity aerobic activity each week, 75 minutes of vigorous-intensity aerobic activity each week, or an equivalent of both. Additional benefits, such as lowering risk for coronary heart disease, stroke, hypertension, type 2 diabetes mellitus, and colon and breast cancer, can be gained by achieving at least five hours of moderate-intensity aerobic activity, or two and a half hours of vigorous-intensity aerobic activity each week [US Department of Health and Human Services (USDHHS), 2009]. In addition to meeting physical activity recommendations, Americans are encouraged to reduce sedentary behavior and screen time. This recommendation is one of the primary concepts that forms the basis of the 2010 Dietary Guidelines Advisory Committee report (report release targeted for June, 2010). Emerging evidence supports such recommendations.

Screen time, obesity, and risk for chronic disease. Epidemiological studies have recently examined the relationship between screen time and obesity. Screen time, a highly modifiable behavior, and obesity have increased in parallel over the past decade (Egger & Swinburn, 1997; Nielsen Media Research, 2009). Studies examining sedentary behaviors have reported a pronounced positive association between time spent viewing television and obesity-related body composition measures such as BMI (kg/m^2), waist circumference, waist-to-hip ratio, and skin fold thickness (Healy et al., 2008; Jakes et al., 2003; Kronenberg et al., 2000; Stamatakis, Hirani, & Rennie, 2009; Thorp et al., 2010).

Reports generated from the Australian Diabetes, Obesity, and Lifestyle (AusDiab) study suggested an association between television viewing time and waist circumference

among adult men and women, with a more pronounced association among women (Healy et al., 2008; Thorp et al., 2010). Healy et al. (2008) examined the dose-response associations of television-viewing time with metabolic risk factors in a large population of physically active Australian adult participants of the 1999-2000 AusDiab study. Waist circumference, blood pressure, and plasma glucose, triglycerides, and high-density lipoprotein cholesterol (HDL-c) concentrations were measured. Time spent viewing the television (hours/day) in the previous week was reported by the participants, and physical activity was measured using the Active Australia questionnaire. These analyses were adjusted for age, education, income, smoking, diet quality, alcohol intake, parental history of diabetes, and total physical activity time, as well as menopause status and postmenopausal hormone use among women. Among adults who met the guideline of two and a half hours per week of moderate- to vigorous-intensity physical activity, television-viewing time was positively associated with increased waist circumference, systolic blood pressure, and 2-hour plasma glucose concentrations in men and women, and with plasma glucose, triglycerides, and HDL-c concentrations in women. Waist circumference attenuated these associations, however, 2-hour plasma glucose concentrations remained significant for men and women, as well as triglycerides and HDL-c concentrations in women.

Analysis of the 2004-2005 AusDiab data yielded similar results. Among women, a detrimental association was observed between television viewing time and waist circumference, BMI, resting blood pressure, triglycerides, HDL-c, fasting and 2-hour postload plasma glucose, and fasting insulin concentrations, however, the associations

were attenuated after adjusting for waist circumference (Thorp et al., 2010). For men, television viewing time was detrimentally associated with all metabolic risk factors except HDL-c concentrations and blood pressure, but after adjusting for waist circumference, only fasting plasma insulin and glucose concentrations remained significant.

The National Heart, Lung, and Blood Institute's (NHLBI) Family Heart Study, a population-based study in the US, reported a significant positive association between television viewing and BMI, waist circumference, waist-to-hip ratio, and skinfold thickness, and a less pronounced (nonsignificant) association with HDL-c and triglyceride concentrations (Kronenberg et al., 2000). The findings of this study also reported that the odds of being overweight increased with quartile of television watching to 2.12 in women and 1.61 in men, independent of leisure time physical activity. Among obese women, watching television only one hour per day and performing at least 75 minutes of moderate-intensity physical activity each week (reference group) was associated with a reduction in BMI of 1.8 kg/m^2 compared to that in women watching television three hours per day and doing the same amount of exercise. Women who engaged in 140 minutes of moderate-intensity physical activity each week and who only watched one hour of television per day had a BMI 0.45 kg/m^2 lower than the reference group.

Stamatakis, Hirani, and Rennie (2009) also reported an independent positive association between television viewing and obesity, regardless of the amount of physical activity a person performs. The 2003 Scottish Health Survey included participants aged

16 years and over, and measurements of height, weight, and waist circumference were collected. Participants reported screen time: that spent watching television, using the computer, and playing video games. Participants reporting ≥ 4 h/d of screen time were more likely to have a BMI and waist circumference indicative of obesity (BMI ≥ 30 kg/m²; waist circumference ≥ 88 cm in women and ≥ 102 cm in men). Similar to findings by Kronenberg et al. (2000), the prevalence of obesity remained high for participants who met physical activity recommendations but reported ≥ 4 h/d of screen time (Stamatakis et al., 2009).

Jakes et al. (2003) and Salmon et al. (2000) reported a positive association between hours of television watched per day and BMI. Using data from the European Prospective Investigation into Cancer (EPIC) study (1993-1997), Jakes et al. (2003) reported that watching ≥ 4 h/d of television was associated with an age-adjusted BMI of 2.0 kg/m² greater when compared to those watching ≤ 2 h/d. Further, the percentage of participants who engaged in vigorous activities significantly decreased as the amount of television watched increased. Salmon, Bauman, Crawford, Timperio, & Owen. (2000) reported that even for physically active adults, watching television for ≥ 4 h/d was associated with a two-fold increased risk of being overweight. Interestingly, among participants in the low, moderate, and high physical activity categories, the odds of being overweight was significantly greater among those who watched television for ≥ 2.5 h/d. However, this relationship was not clear among those in the inactive physical activity category. These researchers suggest that some active people may compensate for their

participation in physical activity by increasing their food intake or increasing sedentary behaviors during other parts of the day (Salmon et al., 2000).

Screen time and dietary intake. Television viewing is associated with increased snacking (Gore, Foster, DiLillo, Kirk, & Smith West, 2003; Thomson, Spence, Raine, & Laing, 2008), and mixed findings have been reported regarding the association between television viewing and energy and macronutrient intake (Bowman, 2006; Gore et al., 2003; Johnson, Nelson, & Bradley, 2006). Television viewing may encourage increased dietary intake by two mechanisms. Advertisements may stimulate the desire to consume a specific type of energy dense food, and television may distract individuals from satiety and disappearance cues, resulting in an increase in food intake (Borzekowski & Robinson, 2001; Chamberlain, Wang, & Robinson, 2006; Hetherington, 2007; Young, 2003).

To investigate the relationship between television viewing time and dietary intake, Bowman (2006) conducted a study dividing adult participants of the USDA's Continuing Survey of Food Intakes by Individuals (1994-1996) into three television-viewing categories: <1 h/d, 1-2 h/d, and >2 h/d. Dietary intake data in this study was collected through interviewer-administered 24-hour dietary-recalls on two consecutive days, and screen time was self-reported. Participants who watched >2 h/d of television reported consuming higher energy, total fat, carbohydrate, and protein, and less fiber compared to adults who watched <2 h/d. Other studies have shown that eating while watching television may cause an individual to consume more total energy, fat, and snacks (Gore et al., 2003; Johnson et al., 2006). Gore et al. (2003) examined whether

consuming meals and snacks in front of the television was associated with total energy and fat intake among overweight women. Although eating meals while watching television was not associated with total energy or fat intake, snacking while watching television was.

Similarly, other researchers have observed a positive association between obesity, television viewing, and eating while watching television (Johnson et al., 2006). Female veterans were included in a study that examined self-report data from a mailed survey. Researchers reported that both watching >2 h/d of television and eating while watching television were associated with obesity. After adjusting for demographic variables, smoking, physical activity, depression, and post-traumatic stress disorder, women who both watched >2 h/d of television and ate while watching television were nearly twice as likely to be obese.

Studies among children and college students have shown that a substantial percentage of total energy intake is consumed during television viewing (Blass et al., 2006; Matheson, Killen, Wang, Varady, & Robinson, 2004; Stroebele & de Castro, 2004). Among children, Matheson et al. (2004) reported that approximately 17% and 26% of total daily energy was consumed while watching the television on weekdays and weekend days, respectively. Among college students, meal consumption was more frequent during days when the television was on (Stroebele & de Castro, 2004). The increased meal frequency was equivalent to one extra meal. Meals were smaller, however, the net energy intake was higher. Similarly, Blass et al. (2006) reported that the

amount and rate of food consumption was increased when college students watched television.

By reducing sedentary behaviors, such as television viewing, weight gain may be prevented by impacting both sides of the weight balance equation, energy intake and energy output. Eating while watching television, or while participating in other screen time behaviors, may be a potential mechanism linking television viewing to obesity. Unfortunately, limited research examines the relationship between dietary behaviors during screen time use among adults. Therefore, future research should examine the associations between screen time and detrimental dietary patterns among adults.

Food purchasing behavior

Within the ecological model, supermarkets act as behavioral settings (microlevel environment) that provide multiple opportunities for influencing food purchasing behavior, and hence dietary intake. These opportunities to impact food purchasing may be both beneficial and detrimental to the consumer. From the perspective of a registered dietitian or health educator, supermarket settings offer an important potential to improve eating patterns, and give access to both individuals and groups of people.

The *2005 Dietary Guidelines for Americans* recommend that consumers replace some of the foods in their diet with nutrient-dense options, however, no consistent guideline is in place to help consumers make these important decisions at the supermarket (USDA, 2005). To follow recommendations, consumers need an easy, affordable way to compare the nutrient content of foods and to make healthy food choices. Research has also shown that individuals with a lower educational attainment or

annual income are less likely to follow the Dietary Guidelines when compared to those of higher educational attainment and income (Galobardes, Morabia, & Bernstein, 2001; Giskes, Turrell, van Lenthe, Brug, & Mackenbach, 2006; Mullie, Clarys, Hulens, & Vansant, 2010; Roos, Prattala, Lahelma, Kleemola, & Pietinen, 1996). Populations of lower socioeconomic position (SEP) need extra educational and monetary support with regards to food shopping. Therefore, a healthy shopping study was developed that aimed to test an in-store brief face-to-face healthy shopping intervention to determine whether food purchases of participants who received the intervention differed from those in the control group (Chapter 5). The secondary objective of this study was to determine whether the effects of the healthy shopping intervention varied according to annual household income.

Supermarket interventions. Supermarket interventions that aim to make healthy food shopping easier for the consumer address both behavioral and environmental constructs of the ecological perspective. Supermarket healthy shopping programs have the potential to change the shopping environment by increasing availability, access, and affordability of healthy foods such as fruits and vegetables; by making shopping for healthier options easy for the consumer (through signage and promotions); and have the potential to change the food supply toward offering healthier options. Supermarket interventions also have the potential to change food-purchasing behavior on an individual level, by providing suggestions for breaking habits, recommendations for navigating around the store, and nutrition education.

Point-of-Purchase strategies. Four primary supermarket intervention strategies have been utilized: coupons and price reductions; availability, variety, and convenience for fruit and vegetable purchases; promotion and advertising; and point-of-purchase (POP) information (Ernst et al., 1986; Hunt et al., 1990; Kristal, Goldenhar, Muldoon, & Morton, 1997; Rodgers et al., 1994). Although the shopping interventions that were first tested (mid 1980's and 1990's) reported mixed effectiveness, positive associations have been reported between the amount of health-education material provided by the supermarket and the healthful quality of food purchases (Cheadle et al., 1991). Hence, POP interventions may be a promising strategy to encourage healthful food purchasing at the supermarket.

POP strategies use shelf labels, store signage, brochures, and food demonstrations to specify healthy food choices (Glanz & Yaroch, 2004). The shelf labels often use a color-coded system. For example, all shelf labels that specify a food as reduced sodium are blue and labels that specify a food as heart healthy are red. Research has also shown that supermarket POP interventions have the ability to reach large numbers of people, are low in cost, and are feasible in low-income areas (Lang, Mercer, Tran, & Mosca, 2000; Matson-Koffman, Brownstein, Neiner, & Greaney, 2005; O'Loughlin, Ledoux, Barnett, & Paradis, 1996).

Environmental nutrition interventions can be defined as those that affect availability, access, incentive, or information about foods (Seymour, Yaroch, Serdula, Blanck, & Khan, 2004). A review of nutrition environmental interventions at the POP that took place in supermarkets included all articles published between 1970 and June

2003 (Seymour et al., 2004). The author included interventions that measured change in behavior through sales data, dietary assessment, or physiologic changes; and excluded interventions that only measured psychosocial variables (i.e. awareness or knowledge). Ten grocery store interventions were reviewed. Six of the studies were rated as having a strong or very strong research design (Archabal, McIntyre, Bell, & Tucker, 1987; Ernst et al., 1986; Jeffery, Pirie, Rosenthal, Gerber, & Murray, 1982; Levy, Schucker, Tenney, & Mathews, 1985; Rodgers et al., 1994; Schucker, Levy, Tenney, & Matthews, 1992), and all were conducted in major chain supermarkets. Study length varied from one week to two years. All 10 of the studies used information strategies to promote the purchase of targeted items, and reported sales data. Two of the 10 also included nutrient intake data (Ernst et al., 1986; Kristal et al., 1997). Five of the studies reported increased sales for, at-most, one-half of the targeted items (ie. reduced-fat milk); however specific information common to all successful studies could not be identified (Levy et al., 1985; Rodgers et al., 1994; Schucker et al., 1992; Muller, 1984; Curhan, 1974). The remaining five studies reported no increased sales for targeted items (Achabal et al., 1987; Ernst et al., 1986; Jeffery et al., 1982; Kristal et al., 1997; Soriano & Dozier, 1978). Interestingly, the three interventions that reported the greatest changes in behavior were long-term studies lasting two years (Levy et al., 1985; Rodgers et al., 1994; Schucker et al., 1992).

Recent trials have been conducted to test the effectiveness of supermarket interventions aimed at educating the consumer and improving the nutrient content of food purchases. Mhurchu, Blakely, Jiang, Eyles, & Rodgers (2010) conducted a large (n=1104) trial to evaluate the effect of price discounts and tailored nutrition education on

supermarket purchases. Participants were randomly assigned to one of four groups: price discounts, tailored nutrition education, price discounts and tailored nutrition education, or control. Electronic scanner sales data tracked food purchases, and outcome measures (change in percent energy from saturated fat; protein, carbohydrates, total fat, sugar, energy density, and sodium; and change in quantity of healthier foods purchased by weight) were evaluated at baseline, six months, and twelve months. There were no significant group differences in percent energy from saturated fat, or for any of the additional nutrients investigated, at the end of the 6-month or 12-month follow-up. However, more healthy food items were purchased by those randomized to the price discount group.

Sutherland, Kaley, and Fischer (2010) also recently evaluated the effectiveness of a POP program called Guiding Stars. Currently implemented in supermarkets in the Northeastern US, Guiding Stars is a program that labels food products with stars based on their nutrient composition. To determine the star value (0-3), points are subtracted for *trans* fat, saturated fat, cholesterol, sodium, and added sugar; and added for vitamins, minerals, fiber, and whole grains. Food purchasing data were collected before the Guiding Stars program was implemented, and one and two years after implementation. These researchers did not collect individual shopper purchase data, but instead compared the volume of foods purchased with 0-, 1-, 2-, and 3-star ratings. Their findings suggested that consumers purchased significantly more items with star ratings at the one- and two-year follow-up periods, suggesting that incremental changes in healthful food purchasing may change long-term behavior. When researchers examined only ready-to-eat cereals,

they found that consumers also purchased significantly more cereals with stars than without. This finding suggests that after implementation of the program, consumers were purchasing more ready-to-eat cereals with less added sugar and more fiber, as opposed to high-sugar, low-fiber cereals.

The Healthy Food Hawaii intervention combined environmental and POP strategies to increase the availability of healthy foods and promote healthier food choices and food preparation methods among consumers (Gittelsohn et al., 2010). The POP segment of the intervention included posters, educational displays, and shelf labels to promote healthier food items, such as beverages (water, diet soda), snack foods for children (whole grain, lower sugar cereals), condiments (light mayonnaise, low-fat salad dressings), and meals (drain and rinse ground meat, tuna in water). At the end of the eight-week trial period, 24-hour dietary recalls were collected and Healthy Eating Index scores were calculated for each participant (n=117). When intervention stores were compared to control stores, there were no differences in adult HEI scores. However, sales of several of the promoted foods increased in stores implementing the intervention.

Researchers have encouraged additional research addressing the impact of POP nutrition interventions in supermarkets. Future research should utilize successful strategies from previous research, use consistent outcome variables, and test models that are already implemented in the environment. Health promotion programs that are implemented in this type of environmental modality may be beneficial because they provide exposure to individuals and groups of people, can be low cost, and upon success, suggest grand implications for policy improvement with regards to population nutrition.

Summary

An ecological perspective was used when developing the studies included in this dissertation. Proposed by Egger and Swinburn (1997), their ecological model suggests three main influences on equilibrium levels of body fat: biological, behavioral, and environmental. Their model also used total energy as a mediator and therefore two of the four manuscripts address energy expenditure and three of the four address energy intake.

Aligned with the biological and behavioral influences of the ecological model, we designed a study to assess dietary quality among Hispanic and non-Hispanic white women, and to examine the relationship between dietary quality and markers of obesity. Dietary quality was examined using the Healthy Eating Index (HEI)-2005, which assessed adherence to the US Food Guide Pyramid and Dietary Guidelines for Americans (Hann et al., 2002). Supporting an ecological perspective, the quantity, quality, and diversity of dietary intake has been reported to vary by age, race/ethnicity, socioeconomic factors, and lifestyle factors such as smoking and physical activity (Ford et al., 1998; Guo et al., 2004; McCullough et al., 2002). Because the Latino population (inclusive of individuals who self-identify as Hispanic) is the fastest growing ethnic minority group in the US, understanding the health trends of this population is important (US Census Bureau, 2006).

The ecological perspective aims to understand health behavior by focusing on the nature of individual's transactions with their physical and sociocultural surroundings (Stokols, 1992). Screen time behaviors, such as television viewing and computer use, are considered an environmental influence in the ecological model of obesity (Egger &

Swinburn, 1997). In addition to meeting physical activity recommendations, Americans are encouraged to reduce sedentary behaviors and screen time. Television viewing and computer use are highly prevalent sedentary behaviors in the US, hence, we designed a study that investigated the influence of screen time on obesity. Two manuscripts were developed from this data. The first examined the relationship between reported screen time and markers of obesity; while the second manuscript examined the relationship between screen time and dietary intake. Eating during screen time behaviors may be a potential mechanism linking television viewing to obesity; however, limited research has examined the effects of dietary intake during screen time behaviors. A reduction in sedentary behaviors, such as television viewing, may lead to a reduction in weight gain by impacting both energy output and energy intake.

The final study was designed to investigate the effects of a healthy shopping intervention on the nutrient profile of food purchases. Health education programs implemented in the environment are attractive because they provide exposure to large groups of people and can be low in cost. Supermarket interventions that aim to make shopping for healthy foods easier for the consumer address both behavioral and environmental influences of obesity. They have the potential to change food-purchasing behaviors of individuals by providing nutrition education and shopping tips. Supermarket interventions also have the potential to change the shopping environment by increasing availability, access, and affordability of healthy foods. Evaluation of such interventions can also impact public health through providing useful evidence to policy makers and food providers.

References

- Achabal, D.D., McIntyre, S.H., Bell, C.H., & Tucker, N. (1987). The effect of nutrition P-O-P signs on consumer attitudes and behavior. *Journal of Retail*, 63, 9-24.
- Anderson, L.H., Martinson, B.C., Crain, L., Pronk, N.P., Whitebird, R.R., Fine, L.J., & O'Conner, P.J. (2005). Health care charges associated with physical inactivity, overweight, and obesity. *Preventing Chronic Disease*. Retrieved May 25, 2010, from the Centers for Disease Control and Prevention Official Website: http://www.cdc.gov/pcd/issues/2005/oct/04_0118.htm
- Basiotis, P.P., Carlson, A., Gerrior, S.A., Juan, W.Y., & Lino, M. (2002). The Healthy Eating Index: 1999-2000. CNPP-12. Retrieved September 1, 2008, from the US Department of Agriculture, Center for Nutrition Policy and Promotion Official Website: <http://www.cnpp.usda.gov/>
- Blass, E. M., Anderson, D. R., Kirkorian, H. L., Pempek, T. A., Price, I., & Koleini, M. F. (2006). On the road to obesity: Television viewing increases intake of high-density foods. *Physiology & Behavior*, 88(4-5), 597-604. doi:10.1016/j.physbeh.2006.05.035
- Booth, S. L., Sallis, J. F., Ritenbaugh, C., Hill, J. O., Birch, L. L., Frank, L. D., Glanz, K., Himmelgreen, D. A., Mudd, M., Popkin, B. M., Rickard, K. A., St Jeor, S., & Hays, N. P. (2001). Environmental and societal factors affect food choice and physical activity: Rationale, influences, and leverage points. *Nutrition Reviews*, 59(3 Pt 2), S21-39; discussion S57-65.
- Borzekowski, D. L., & Robinson, T. N. (2001). The 30-second effect: An experiment revealing the impact of television commercials on food preferences of preschoolers. *Journal of the American Dietetic Association*, 101(1), 42-46. doi:10.1016/S0002-8223(01)00012-8
- Bowman, S. A. (2006). Television-viewing characteristics of adults: Correlations to eating practices and overweight and health status. *Preventing Chronic Disease*, 3(2), A38.
- Brownell, K. D., & Wadden, T. A. (1992). Etiology and treatment of obesity: Understanding a serious, prevalent, and refractory disorder. *Journal of Consulting and Clinical Psychology*, 60(4), 505-517.
- Centers for Disease Control and Prevention. National Center for Health Statistics. National Health and Nutrition Examination Survey. Retrieved May 27, 2010, from

the Centers for Disease Control and Prevention Official Website:
<http://www.cdc.gov/nchs/nhanes/>

- Chamberlain, L. J., Wang, Y., & Robinson, T. N. (2006). Does children's screen time predict requests for advertised products? Cross-sectional and prospective analyses. *Archives of Pediatrics & Adolescent Medicine*, *160*(4), 363-368. doi:10.1001/archpedi.160.4.363
- Cheadle, A., Psaty, B. M., Curry, S., Wagner, E., Diehr, P., Koepsell, T., & Kristal, A. (1991). Community-level comparisons between the grocery store environment and individual dietary practices. *Preventive Medicine*, *20*(2), 250-261.
- Egger, G., & Swinburn, B. (1997). An "ecological" approach to the obesity pandemic. *BMJ (Clinical Research Ed.)*, *315*(7106), 477-480.
- Ernst, N. D., Wu, M., Frommer, P., Katz, E., Matthews, O., Moskowitz, J., Pinsky, J. L., Pohl, S., Schreiber, G. B., & Sondik, E. (1986). Nutrition education at the point of purchase: The foods for health project evaluated. *Preventive Medicine*, *15*(1), 60-73.
- Ervin, R. B. (2008). Healthy Eating Index scores among adults, 60 years of age and over, by sociodemographic and health characteristics: United States, 1999-2002. *Advance Data*, *(395)*(395), 1-16.
- Finkelstein, E. A., Fiebelkorn, I. C., & Wang, G. (2003). National medical spending attributable to overweight and obesity: How much, and who's paying? *Health Affairs (Project Hope), Suppl Web Exclusives*, W3-219-26.
- Fitzgerald, A. L., Dewar, R. A., & Veugelers, P. J. (2002). Diet quality and cancer incidence in Nova Scotia, Canada. *Nutrition and Cancer*, *43*(2), 127-132.
- Flegal, K.M. (2005). Epidemiologic aspects of overweight and obesity in the United States. *Physiology & Behavior*, *46*:599-602.
- Flegal, K.M., Graubard, B.I., Williamson, D.F., & Gail, M.H. (2007). Cause-specific excess deaths associated with underweight, overweight, and obesity. *JAMA: Journal of the American Medical Association*, *298*(17):2028-2037.
- Flegal, K. M., Carroll, M. D., Ogden, C. L., & Curtin, L. R. (2010). Prevalence and trends in obesity among US adults, 1999-2008. *JAMA : The Journal of the American Medical Association*, *303*(3), 235-241. doi:10.1001/jama.2009.2014
- Ford, E. S., Will, J. C., De Proost Ford, M. A., & Mokdad, A. H. (1998). Health insurance status and cardiovascular disease risk factors among 50-64-year-old U.S.

- women: Findings from the third National Health and Nutrition Examination Survey. *Journal of Women's Health / the Official Publication of the Society for the Advancement of Women's Health Research*, 7(8), 997-1006.
- Galobardes, B., Morabia, A., & Bernstein, M. S. (2001). Diet and socioeconomic position: Does the use of different indicators matter? *International Journal of Epidemiology*, 30(2), 334-340.
- Gao, S. K., Beresford, S. A., Frank, L. L., Schreiner, P. J., Burke, G. L., & Fitzpatrick, A. L. (2008). Modifications to the healthy eating index and its ability to predict obesity: The multi-ethnic study of atherosclerosis. *The American Journal of Clinical Nutrition*, 88(1), 64-69.
- Giskes, K., Turrell, G., van Lenthe, F. J., Brug, J., & Mackenbach, J. P. (2006). A multilevel study of socio-economic inequalities in food choice behaviour and dietary intake among the Dutch population: The GLOBE study. *Public Health Nutrition*, 9(1), 75-83.
- Gittelsohn, J., Vijayadeva, V., Davison, N., Ramirez, V., Cheung, L. W., Murphy, S., & Novotny, R. (2010). A food store intervention trial improves caregiver psychosocial factors and children's dietary intake in Hawaii. *Obesity (Silver Spring, Md.)*, 18 Suppl 1, S84-90. doi:10.1038/oby.2009.436
- Glanz, K., & Yaroch, A. L. (2004). Strategies for increasing fruit and vegetable intake in grocery stores and communities: Policy, pricing, and environmental change. *Preventive Medicine*, 39 Suppl 2, S75-80. doi:10.1016/j.ypmed.2004.01.004
- Gore, S. A., Foster, J. A., DiLillo, V. G., Kirk, K., & Smith West, D. (2003). Television viewing and snacking. *Eating Behaviors*, 4(4), 399-405. doi:10.1016/S1471-0153(03)00053-9
- Guenther, P. M., Reedy, J., & Krebs-Smith, S. M. (2008). Development of the Healthy Eating Index-2005. *Journal of the American Dietetic Association*, 108(11), 1896-1901. doi:10.1016/j.jada.2008.08.016
- Guenther, P.M., Juan, W.Y., Reedy, J., Britten, P., Lino, M., Carlson, A...Krebs-Smith, S. (2008a). Diet quality of Americans in 1994-96 and 2001-02 as measured by the Healthy Eating Index-2005. Nutrition Insight 37. US Department of Agriculture (USDA), Center for Nutrition Policy and Promotion. Retrieved September 1, 2008, from the USDA, Center for Nutrition Policy and Promotion Official Website: <http://www.cnpp.usda.gov/Publications/NutritionInsights/>

- Guo, X., Warden, B. A., Paeratakul, S., & Bray, G. A. (2004). Healthy Eating Index and obesity. *European Journal of Clinical Nutrition*, 58(12), 1580-1586.
doi:10.1038/sj.ejcn.1601989
- Hann, C. S., Rock, C. L., King, I., & Drewnowski, A. (2001). Validation of the Healthy Eating Index with use of plasma biomarkers in a clinical sample of women. *The American Journal of Clinical Nutrition*, 74(4), 479-486.
- Healy, G. N., Dunstan, D. W., Salmon, J., Shaw, J. E., Zimmet, P. Z., & Owen, N. (2008). Television time and continuous metabolic risk in physically active adults. *Medicine and Science in Sports and Exercise*, 40(4), 639-645.
doi:10.1249/MSS.0b013e3181607421
- Hetherington, M. M. (2007). Cues to overeat: Psychological factors influencing overconsumption. *The Proceedings of the Nutrition Society*, 66(1), 113-123.
doi:10.1017/S0029665107005344
- Huijbregts, P., Feskens, E., Rasanen, L., Fidanza, F., Nissinen, A., Menotti, A., & Kromhout, D. (1997). Dietary pattern and 20 year mortality in elderly men in Finland, Italy, and the Netherlands: Longitudinal cohort study. *BMJ (Clinical Research Ed.)*, 315(7099), 13-17.
- Hunt, M. K., Lefebvre, R. C., Hixson, M. L., Banspach, S. W., Assaf, A. R., & Carleton, R. A. (1990). Pawtucket heart health program point-of-purchase nutrition education program in supermarkets. *American Journal of Public Health*, 80(6), 730-732.
- Jakes, R. W., Day, N. E., Khaw, K. T., Luben, R., Oakes, S., Welch, A., Bingham, S., & Wareham, N. J. (2003). Television viewing and low participation in vigorous recreation are independently associated with obesity and markers of cardiovascular disease risk: EPIC-Norfolk population-based study. *European Journal of Clinical Nutrition*, 57(9), 1089-1096. doi:10.1038/sj.ejcn.1601648
- Johnson, K. M., Nelson, K. M., & Bradley, K. A. (2006). Television viewing practices and obesity among women veterans. *Journal of General Internal Medicine*, 21 Suppl 3, S76-81. doi:10.1111/j.1525-1497.2006.00379.x
- Kant, A. K., Schatzkin, A., Graubard, B. I., & Schairer, C. (2000). A prospective study of diet quality and mortality in women. *JAMA : The Journal of the American Medical Association*, 283(16), 2109-2115.
- Katahn, M., & McMinn, M.R. (1990). Obesity: a biobehavioral point of view. *Annals of the New York Academy of Science*, 602, 189-204.

- Kristal, A. R., Goldenhar, L., Muldoon, J., & Morton, R. F. (1997). Evaluation of a supermarket intervention to increase consumption of fruits and vegetables. *American Journal of Health Promotion : AJHP*, 11(6), 422-425.
- Kronenberg, F., Pereira, M. A., Schmitz, M. K., Arnett, D. K., Evenson, K. R., Crapo, R. O., Jensen, R. L., Burke, G. L., Sholinsky, P., Ellison, R. C., & Hunt, S. C. (2000). Influence of leisure time physical activity and television watching on atherosclerosis risk factors in the NHLBI family heart study. *Atherosclerosis*, 153(2), 433-443.
- Kumanyika, Jeffery, Morabia, Ritenbaugh, and Antipatis. (2010). "Obesity Prevention: The Case for Action: A Report of the Public Health Approaches to the Prevention Obesity Working Group of the International Obesity Task Force." Retrieved June 7, 2010, from the International Association for the Study of Obesity Official Website: www.ionf.org
- Lang, J. E., Mercer, N., Tran, D., & Mosca, L. (2000). Use of a supermarket shelf-labeling program to educate a predominately minority community about foods that promote heart health. *Journal of the American Dietetic Association*, 100(7), 804-809. doi:10.1016/S0002-8223(00)00234-0
- Leibel, R. L., Rosenbaum, M., & Hirsch, J. (1995). Changes in energy expenditure resulting from altered body weight. *The New England Journal of Medicine*, 332(10), 621-628.
- Matheson, D. M., Killen, J. D., Wang, Y., Varady, A., & Robinson, T. N. (2004). Children's food consumption during television viewing. *The American Journal of Clinical Nutrition*, 79(6), 1088-1094.
- Matson-Koffman, D. M., Brownstein, J. N., Neiner, J. A., & Greaney, M. L. (2005). A site-specific literature review of policy and environmental interventions that promote physical activity and nutrition for cardiovascular health: What works? *American Journal of Health Promotion : AJHP*, 19(3), 167-193.
- McCullough, M. L., Feskanich, D., Stampfer, M. J., Giovannucci, E. L., Rimm, E. B., Hu, F. B., Spiegelman, D., Hunter, D. J., Colditz, G. A., & Willett, W. C. (2002). Diet quality and major chronic disease risk in men and women: Moving toward improved dietary guidance. *The American Journal of Clinical Nutrition*, 76(6), 1261-1271.
- Milewicz, A., Mikulski, E., & Bidzinska, B. (2000). Plasma insulin, cholecystokinin, galanin, neuropeptide Y and leptin levels in obese women with and without type 2 diabetes mellitus. *International Journal of Obesity and Related Metabolic Disorders*

: *Journal of the International Association for the Study of Obesity*, 24 Suppl 2, S152-3.

- Mullie, P., Clarys, P., Hulens, M., & Vansant, G. (2010). Dietary patterns and socioeconomic position. *European Journal of Clinical Nutrition*, 64(3), 231-238. doi:10.1038/ejcn.2009.145
- Murtaugh, M. A., Herrick, J. S., Sweeney, C., Baumgartner, K. B., Guiliano, A. R., Byers, T., & Slattery, M. L. (2007). Diet composition and risk of overweight and obesity in women living in the southwestern United States. *Journal of the American Dietetic Association*, 107(8), 1311-1321. doi:10.1016/j.jada.2007.05.008
- National Center for Chronic Disease Prevention and Health Promotion. Obesity trends among US adults between 1985 and 2008. Retrieved May 25, 2010, from the Centers for Disease Control and Prevention Official Website: www.cdc.gov/nccdphp/dnpa/obesity/
- National Institutes of Health. (1998). Clinical guidelines on the identification, evaluation and treatment of overweight and obesity in adults: the evidence report. *Obes Res*;6(Suppl 2):51S-209S.
- Neuhouser, M. L., Thompson, B., Coronado, G. D., & Solomon, C. C. (2004). Higher fat intake and lower fruit and vegetables intakes are associated with greater acculturation among Mexicans living in Washington State. *Journal of the American Dietetic Association*, 104(1), 51-57. doi:10.1016/j.jada.2003.10.015
- Newby, P. K., Muller, D., Hallfrisch, J., Andres, R., & Tucker, K. L. (2004). Food patterns measured by factor analysis and anthropometric changes in adults. *The American Journal of Clinical Nutrition*, 80(2), 504-513.
- Ogden, C. L., Yanovski, S. Z., Carroll, M. D., & Flegal, K. M. (2007). The epidemiology of obesity. *Gastroenterology*, 132(6), 2087-2102. doi:10.1053/j.gastro.2007.03.052
- O'Loughlin, J., Ledoux, J., Barnett, T., & Paradis, G. (1996). La Commande du Coeur ("Shop for Your Heart"): A point-of-choice nutrition education campaign in a low-income urban neighborhood. *American Journal of Health Promotion : AJHP*, 10(3), 175-178.
- Osler, M., Heitmann, B. L., Hoidrup, S., Jorgensen, L. M., & Schroll, M. (2001). Food intake patterns, self rated health and mortality in Danish men and women. A prospective observational study. *Journal of Epidemiology and Community Health*, 55(6), 399-403.

- Rodgers, A. B., Kessler, L. G., Portnoy, B., Potosky, A. L., Patterson, B., Tenney, J., Thompson, F. E., Krebs-Smith, S. M., Breen, N., & Mathews, O. (1994). "Eat for health": A supermarket intervention for nutrition and cancer risk reduction. *American Journal of Public Health, 84*(1), 72-76.
- Roos, E., Prattala, R., Lahelma, E., Kleemola, P., & Pietinen, P. (1996). Modern and healthy?: Socioeconomic differences in the quality of diet. *European Journal of Clinical Nutrition, 50*(11), 753-760.
- Salmon, J., Bauman, A., Crawford, D., Timperio, A., & Owen, N. (2000). The association between television viewing and overweight among Australian adults participating in varying levels of leisure-time physical activity. *International Journal of Obesity and Related Metabolic Disorders: Journal of the International Association for the Study of Obesity, 24*(5), 600-606.
- Seymour, J. D., Calle, E. E., Flagg, E. W., Coates, R. J., Ford, E. S., Thun, M. J., & American Cancer Society. (2003). Diet quality index as a predictor of short-term mortality in the American cancer society cancer prevention study II nutrition cohort. *American Journal of Epidemiology, 157*(11), 980-988.
- Seymour, J. D., Yaroch, A. L., Serdula, M., Blanck, H. M., & Khan, L. K. (2004). Impact of nutrition environmental interventions on point-of-purchase behavior in adults: A review. *Preventive Medicine, 39 Suppl 2*, S108-36.
doi:10.1016/j.yjpm.2004.04.002
- Stamatakis, E., Hirani, V., & Rennie, K. (2009). Moderate-to-vigorous physical activity and sedentary behaviours in relation to body mass index-defined and waist circumference-defined obesity. *The British Journal of Nutrition, 101*(5), 765-773.
doi:10.1017/S0007114508035939
- Stokols, D. (1992). Establishing and maintaining healthy environments. Toward a social ecology of health promotion. *The American Psychologist, 47*(1), 6-22.
- Stroebele, N., & de Castro, J. M. (2004). Television viewing is associated with an increase in meal frequency in humans. *Appetite, 42*(1), 111-113.
doi:10.1016/j.appet.2003.09.001
- Thompson, F. E., Midthune, D., Subar, A. F., McNeel, T., Berrigan, D., & Kipnis, V. (2005). Dietary intake estimates in the National Health Interview survey, 2000: Methodology, results, and interpretation. *Journal of the American Dietetic Association, 105*(3), 352-63; quiz 487. doi:10.1016/j.jada.2004.12.032

- Thomson, M., Spence, J. C., Raine, K., & Laing, L. (2008). The association of television viewing with snacking behavior and body weight of young adults. *American Journal of Health Promotion, 22*(5), 329-335.
- Thorp, A. A., Healy, G. N., Owen, N., Salmon, J., Ball, K., Shaw, J. E., Zimmet, P. Z., & Dunstan, D. W. (2010). Deleterious associations of sitting time and television viewing time with cardiometabolic risk biomarkers: Australian diabetes, obesity and lifestyle (AusDiab) study 2004-2005. *Diabetes Care, 33*(2), 327-334. doi:10.2337/dc09-0493
- Trichopoulou, A., Kouris-Blazos, A., Wahlqvist, M. L., Gnardellis, C., Lagiou, P., Polychronopoulos, E., Vassilakou, T., Lipworth, L., & Trichopoulos, D. (1995). Diet and overall survival in elderly people. *British Medical Journal (Clinical Research Ed.), 311*(7018), 1457-1460.
- US Department of Health and Human Services (USDHHS), & US Department of Agriculture (USDA). (2005). *Dietary guidelines for Americans 2005*. Retrieved March 15, 2008, from the USDHHS Official Website: <http://www.healthierus.gov/dietaryguidelines>.
- Wirt, A., & Collins, C. E. (2009). Diet quality--what is it and does it matter? *Public Health Nutrition, 12*(12), 2473-2492. doi:10.1017/S136898000900531X
- World Health Organization (WHO). (2001). Turning the tide of malnutrition: responding to the challenge of the 21st century. Retrieved May 25, 2010, from the World Health Organization Official Website: <http://www.who.int/en/>
- WHO. (2006). Obesity and overweight: What are overweight and obesity? Retrieved May 25, 2010, from the World Health Organization Official Website: <http://www.who.int/topics/obesity/en/>
- Young, B. (2003). Does food advertising influence children's food choices? *International Journal of Advertising, 22*, 441-459.

Chapter 2

Lower Dietary Quality In Young Hispanic Women In The Southwestern United States

Abstract

Obesity among Hispanic Arizonans nearly doubled between 2002 and 2007. Therefore, assessing dietary quality is important for designing appropriate interventions and determining policy directions. The objective of this study was to compare dietary quality between Hispanic and non-Hispanic white (NHW) women using the Healthy Eating Index (HEI)-2005 and to examine the relationship between total HEI score and selected indicators of obesity. Using 7-day weighed food records, dietary quality was determined, and height, weight, waist circumference, and body mass index [BMI] were assessed among Hispanic (n = 32) and NHW (n = 42) women. Total percent body fat and percent trunk fat were determined by dual energy x-ray absorptiometry. Compared to NHW, Hispanic women had lower total HEI scores (Hispanic = 47.0 ± 9.9 ; NHW = 52.5 ± 11.8 ; $P < 0.05$), and lower scores for total vegetables (Hispanic = 1.8 ± 0.9 ; NHW = 2.5 ± 1.1 ; $P < 0.05$), dark green and orange vegetables and legumes (Hispanic = 0.4 ± 0.5 ; NHW = 1.0 ± 1.1 ; $P < 0.05$), and sodium (Hispanic = 3.0 ± 1.7 ; NHW = 3.7 ± 1.4 ; $P < 0.05$). Negative correlations were found between total HEI-2005 score and waist circumference ($r = -0.271$, $P < 0.05$), total percent body fat ($r = -0.288$, $P < 0.05$), and percent trunk fat ($r = 0.343$, $P < 0.01$). Hispanic women had lower overall dietary quality, and poor dietary quality was positively associated with selected indicators of obesity. Nutrition interventions among Hispanic women should focus on increasing vegetable and lowering sodium consumption.

Introduction

Obesity rates have dramatically increased over the past 25 years, with more than 72 million people estimated to be obese in the US in 2005-2006 (Ogden, Carroll, McDowell, & Flegal, 2007). The greatest increases in obesity have been observed among those with some college education and those of Hispanic ethnicity (Mokdad et al., 1999). Data from the National Health and Nutrition Examination Survey (NHANES) 2003-2004 indicated that Hispanic and non-Hispanic black women were significantly more likely to be obese compared to non-Hispanic white women (NHW) (Ogden et al., 2006). Between the years of 2003 and 2004, the prevalence of obesity among NHW and Hispanic women was 30.6% and 36.8%, respectively.

One quarter of the Arizona population is of Hispanic or Latino race/ethnicity (compared with the national 15.5% projection for 2010) [Arizona Department of Health Services (AZDHS), 2007; US Census Bureau, 2006]. Therefore, understanding health behaviors among Hispanic populations in Arizona is important. Although the prevalence of obesity in Arizona ranks 31st in the US (25.8%), greater differences are seen in obesity prevalence in Arizona among Hispanic (36.5%) and NHW (23.6%) individuals, when compared to national averages (AZDHS, 2007). This discrepancy warrants further investigation into factors influencing obesity.

Due to rapidly changing state and national demographics, monitoring the factors influencing obesity in subpopulation groups is important to improve the health of the nation. Recently, Murtaugh et al. reported higher consumption of total energy and fat among Hispanic women when compared to NHW women (Murtaugh et al., 2007).

Larkey et al. found significant differences in the dietary practices and sources of calcium intake when comparing Hispanic and non-Hispanic women living in Arizona (Larkey, Day, Houtkooper, & Renger, 2003). Hispanic women reported consuming significantly more corn tortillas and beans, and fewer servings of milk products when compared to non-Hispanic women. Other research has described dietary patterns among Hispanics of Mexican descent that consistently include sweetened drinks, saturated fats, and processed foods (Carrera, Gao, & Tucker, 2007). Dietary quality is important to assess in a population in order to monitor adherence to dietary recommendations, develop and evaluate interventions, and shape policy initiatives.

Healthy Eating Index-2005

Incorporating the nearly 90 individual nutrient intakes into a comprehensive dietary analysis remains a challenge (Coulston, 2001). People eat food, not nutrients; therefore, specific nutrient recommendations may be confusing to the layperson. Further, phytonutrients in foods are not typically included in dietary analysis software. Researchers in the US have developed various methods to measure dietary quality by assessing consumption of food types and groups (versus individual nutrients). The Dietary Quality Index and the Healthy Eating Index (HEI) are two measures used to evaluate overall dietary quality (Kennedy, Ohls, Carlson, & Fleming, 1995; Patterson, Haines, & Popkin, 1994). The United States Department of Agriculture (USDA) Center for Nutrition Policy and Promotion (CNPP) created the HEI as a validated measure of dietary quality (Guenther, Juan, Reedy, et al., 2008a; Guenther, Reedy, Krebs-Smith, & Reeve, 2008c). The HEI is a summary measure of the overall quality of people's diets

and was developed to measure compliance with the Dietary Guidelines for Americans, to monitor change in the diets of US populations, and to help promote healthier eating lifestyles (Basiotis P.P., Carlson A., Gerrior S.A., Juan W.Y., Lino M., 2002; Guenther,P.M., Juan W.Y., Reedy J., et al., 2008a). The original HEI was revised to reflect the 2005 Dietary Guidelines for Americans (HEI-2005), placing emphasis on characteristics of dietary quality, such as whole grains, various types of vegetables, specific types of fat, and discretionary calories (the calories from solid fat, alcohol, and added sugar).

The importance of assessing dietary quality was highlighted when the Institute of Medicine (IOM) released a report recommending the best measures for the health of a nation (IOM, 2008). The committee selected 20 key health indicators valuable in overall health assessment. To improve nutrition, this report encouraged all adults to consume a healthy diet, measured as a total HEI score >80 on the Healthy Eating Index-2005.

Dietary quality & health

The quantity, quality, and diversity of dietary intake vary by age, race/ethnicity, education, income, acculturation, health status, and possession of health insurance (Ford, Will, De Proost Ford, & Mokdad, 1998). Further, dietary quality has been correlated with obesity and chronic disease risk factors (Ervin, 2008; Gao et al., 2008; Hann, Rock, King, & Drewnowski, 2001; McCullough et al., 2002; Newby, Muller, Hallfrisch, Andres, & Tucker, 2004). Dietary quality may also vary by lifestyle factors such as smoking, alcohol consumption, and physical activity (Guo, Warden, Paeratakul, & Bray, 2004; McCullough et al., 2002).

McCullough et al. analyzed food frequency questionnaire (FFQ) data from male and female participants in the Health Professional's Follow-up Study and the Nurses' Health Study (McCullough et al., 2002). Dietary quality, assessed by the Alternative HEI (AHEI), was associated with healthy lifestyle behaviors in men and women. The AHEI incorporates several components of the original HEI, but also provides scoring for qualitative dietary guidance such as alcohol consumption in moderation and choosing more fish, poultry, and whole grain foods. In this study, women (AHEI= 38.4 ± 10.3) had a slightly lower AHEI score than men (AHEI = 45.0 ± 11.1), and participants with higher dietary quality were less likely to smoke, slightly older, and engaged in more physical activity. Overall, the AHEI score was strongly inversely associated with risk of cardiovascular disease (CVD). Men in the highest AHEI quintile had a 39% lower risk of CVD than did men in the lowest AHEI quintile.

Among women, increased AHEI scores predicted a significant reduction in major chronic disease risk, however, predictions were weaker than those for men. More research is necessary to strengthen the literature addressing the association between dietary quality and lifestyle behaviors. Further, because geographic location may be associated with dietary intake of foods, such as fruits and vegetables (National Center for Chronic Disease Prevention and Health Promotion, 2007), researchers should consider locality as an important characteristic. To our knowledge, the present study is the first to examine dietary quality using the HEI-2005 among subpopulations in the Southwest, specifically Arizona.

Objective

The primary objective of this study was to assess dietary quality among young Hispanic and NHW women in Arizona using the HEI-2005. The secondary objective of this study was to examine the relationship between total HEI score and markers of obesity [waist circumference, total percent body fat, percent trunk fat, and body mass index (BMI)]. Although previous literature has found different dietary patterns among Hispanic and NHW populations, dietary quality estimates for US subpopulations have not yet been determined via the HEI-2005 assessment method. Understanding dietary patterns of US subpopulations will help in monitoring population adherence with dietary recommendations, guiding nutrition education, designing and evaluating nutrition interventions, and directing nutrition-related public policy.

Materials and Methods

Study design

This study utilized a cross-sectional design comparing dietary quality via the HEI-2005 among Hispanic and NHW women residing in the Greater Phoenix area in Arizona. The methods included 7-day weighed food records, anthropometric assessment [height, weight, and waist circumference, and percent body fat using dual-energy x-ray absorptiometry (DXA)], and assessment of dietary quality via the HEI-2005.

Researchers distributed recruitment flyers at local colleges, school districts, health clinics, fitness centers, community outreach programs, and other public locations in the Greater Phoenix area beginning in November 2004. The Greater Phoenix area includes more than 20 cities and towns. Interested participants were encouraged to call the study researchers for more information. The participant screening process occurred at the time

of the initial telephone call by the participant. If eligible, participants were invited to schedule a first study visit. Women were included in the study if they fit the following criteria: Hispanic or NHW race/ethnicity; between 20 and 40 years of age; weight stable (no weight fluctuation of 10% or more in the past 6 months); nonsmoker (defined by no use of cigars, cigarettes, or other tobacco products in the past 6 months); regular menstruation (defined by at least 10 periods in the past year); and no pregnancy, lactation, or uncontrolled thyroid disorder in the past year. Each woman self-reported her ethnicity by having at least one parent matching the self-identification of the participant. For example, if the participant identified herself as Hispanic, she was categorized into the Hispanic group as long as one of her parents was identified as Hispanic. Participants signed an informed consent form and completed a health questionnaire that included a question about education level attainment. Materials were available in English and Spanish and a translator was available for participants who preferred to speak Spanish. Data collection and participant visits occurred in the Department of Nutrition at Arizona State University (ASU) and the University Institutional Review Board at ASU approved this study.

Dietary assessment

Participants completed 7-day consecutive weighed food records of foods and beverages (except water) consumed during five weekdays and two weekend days to determine their usual eating patterns. Each participant was given a food scale and was instructed to weigh all foods before consumption to ensure accuracy in reporting portion sizes. Detailed food record instruction was given verbally using food models. Participants

were reminded to record all foods and beverages, including condiments and items added to foods, such as salt, sugar, and cream. Written instructions were given to the participants to take home. In addition to recording food, participants were encouraged to record the brand, preparation method, and amount. Dietary intake was analyzed by Food Processor Nutrition and Fitness Software (version 8.5, 2005, ESHA Research, Salem, OR). Total energy and macronutrient intakes were computed. Dietary intake and anthropometry data were collected during 2004-2005.

Anthropometry

Height, weight, and waist circumference were determined during the anthropometric assessments. Using a Seca 214 stadiometer (Seca Corporation, Hanover, MA; Ontario, CA), height was measured to the nearest 0.1 cm, without shoes and with the participant's back against wall. The participant's weight was measured to the nearest 0.1 kg using a Seca Bella 840 digital scale (Seca Corporation, Hanover, MA; Ontario, CA). BMI (kg/m^2) was calculated using the participant's height (m) and weight (kg). Waist circumference was measured in triplicate using a non-stretchable Gullick II measuring tape (County Technology, Inc., Gay Mills, WI) to the nearest 0.1 cm at the level of the iliac crest. Total percent body fat and percent trunk fat were determined by a DXA scan (GE Lunar Prodigy Pro, Chalfont St. Giles, United Kingdom). A DXA scan utilizes x-ray conversion technology so that bone density, body fat, and nonbone lean tissue can be assessed in one exam. DXA is the preferred method used to diagnose osteoporosis because of the high precision in measuring bone density. Estimates of

percent body fat from DXA have been found to be highly correlated with those from underwater weighing (Roubenoff, Kehayias, Dawson-Hughes, & Heymsfield, 1993).

HEI assessment

The HEI-2005 was used to assess dietary quality. Food component standards are based on the recommendations found in MyPyramid and are expressed as a percent of energy (or per 1,000 calories) (Guenther, Reedy, & Krebs-Smith, 2008b; Guenther, Reedy, Krebs-Smith, & Reeve, 2008c). Based on aspects of the Dietary Guidelines, the HEI-2005 components include total fruit (cups), whole fruit (excluding juice) (cups), total vegetables (cups), dark green and orange vegetables and legumes (cups), total grains (oz), whole grains (oz), milk (cups), meat and beans (oz), oils (g), saturated fat (percent energy), sodium (g), and calories from solid fat, alcohol, and added sugar (percent energy). In the HEI-2005 revision, researchers modified individual components that were included in the analysis, and based the HEI scoring on a density approach, expressed per 1,000 kcal. Hence, variation in energy intake does not interfere with the diet quality outcome. The total score is the sum of 12 component scores, each component representing a different food group or type. A higher total HEI score reflects greater dietary quality (maximum 100). Higher intake (per 1,000 calories) of the first nine components earns a higher component score. Lower intake of the last three components (saturated fat, sodium, and calories from solid fat, alcohol, and sugar) earns a higher component score. For example, a lower intake of sodium results in a higher component score for sodium. The higher the total HEI score, the better the dietary quality.

Guidelines for HEI-2005 scoring were described by Guenther et al. in the *Development and Evaluation of the Healthy Eating Index-2005: Technical Report* (Guenther, Reedy, & Krebs-Smith, 2008b; Guenther, Reedy, Krebs-Smith, & Reeve, 2008c). Each food item included in the participant's 7-day dietary record was categorized into one of the 12 HEI-2005 components. Scores for each day were calculated and a 7-day average was computed. Atypical food items, such as mixed dishes, were scored considering all the ingredients in the dish. The American Diabetes Association exchange lists were used to determine macronutrient composition (Daly, Evert, Franz, et al., 2008). Weekly meetings were held with co-investigators to standardize methodology and ensure scoring consistency and accuracy. HEI-2005 analysis was performed in 2008.

Statistical analysis

Statistical analysis was performed using SPSS (version 15.0, 2006, SPSS Institute Inc, Chicago, IL) and results were considered significant if $P < 0.05$. Values are expressed as mean \pm standard deviation. Descriptive characteristics were computed for each group (age, height, weight, BMI, percent body fat, and percent trunk fat), dietary intake [energy, macronutrient intake (g, percent energy), fiber, cholesterol, calcium, and vitamin C], and dietary quality (HEI-2005 components). Normality for the outcome variables was examined using histograms and the Kolmogorov Smirnov test statistic. Whole fruit (cups), dark green and orange vegetables and legumes (cups), total grains (oz), whole grains (oz), oils (g), and calories from solid fat, alcohol, and added sugar (percent energy) were not normally distributed; nonparametric statistics were used for analysis. Total HEI-2005 scores and each of the 12 HEI-2005 component scores were

compared between Hispanic and non-Hispanic white women using independent sample t-tests and Mann-Whitney U procedures. The association between markers of obesity (waist circumference, total percent body fat, percent trunk fat, and BMI) and total HEI scores for both groups of women combined were examined using Pearson product-moment correlation coefficients.

Results

Seventy-four participants were included in the final analysis (32 Hispanic and 42 NHW). Descriptive characteristics of participants are displayed in Table 1. No significant differences were found between Hispanic and NHW women in age, weight, BMI, waist circumference, total percent body fat, and percent trunk fat. Hispanic women were significantly shorter than the NHW women ($P < 0.05$). Thirty-seven percent of Hispanic participants and 57% of NHW participants reported they were at least college graduates.

Participant dietary intake is displayed in Table 2. No significant differences were observed between groups for reported dietary intake. Reported dietary fiber intake was below the recommended range. Total protein, carbohydrate, and fat intakes fell within the Acceptable Macronutrient Distribution Range (IOM, 2002).

When compared to NHW participants, Hispanic women had significantly lower HEI-2005 scores for total HEI-2005 score (Hispanic = 47.0 ± 9.9 ; NHW = 52.5 ± 11.8 ; $P < 0.05$), total vegetables (Hispanic = 1.8 ± 0.9 ; NHW = 2.5 ± 1.1 ; $P < 0.05$), dark green and orange vegetables and legumes (Hispanic = 0.4 ± 0.5 ; NHW = 1.0 ± 1.1 ; $P < 0.05$), and sodium (Hispanic = 3.0 ± 1.7 ; NHW = 3.7 ± 1.4 ; $P < 0.05$) (Table 3). The HEI-2005 score comparison for total vegetables equates to approximately a one cup difference

between groups per week, and a little less than a half cup per week difference for dark green and orange vegetables and legumes. The Institute of Medicine recently recommended that all adults have a total HEI-2005 ≥ 80 (IOM, 2008). In this study, there were no participants who met that recommendation.

Pearson product-moment correlation coefficients were used to explore the relationship between total HEI-2005 score and markers of obesity (waist circumference, total percent body fat, percent trunk fat, and BMI) (Table 4). Significant negative correlations were found between total HEI-2005 score and waist circumference ($r = -0.271$, $P < 0.05$), total percent body fat ($r = -0.288$, $P < 0.05$), and percent trunk fat ($r = -0.343$, $P < 0.01$).

Discussion

When using the HEI-2005, we found lower overall dietary quality, a lower intake of total vegetables and dark green and orange vegetables and legumes, and higher sodium intake among Hispanic when compared to NHW women in this study. Interestingly, there were no significant differences in reported dietary intake (calories/d, percent energy from protein, percent energy from carbohydrate, percent energy from fat, percent energy from saturated fat, and cholesterol mg/d) using 7-day weighed food records among the two groups of women, perhaps indicating an increase in sensitivity of HEI-2005 methodology when examining the adequacy of dietary intake. Results of this study suggest that nutrition interventions for Hispanic women should focus on increasing vegetable and legume consumption and reducing sodium intake rather than focusing on reducing fat and

sugar intake. When individuals increase their fruit and vegetable intake, these new foods may replace those of lower nutritional quality, such as foods high in fat and sugar.

When comparing HEI-2005 scores among Hispanic and NHW women, NHW women in this study reported consuming one more cup per week of total vegetables and nearly a half cup more per week of dark green and orange vegetables and legumes than Hispanic women. Research has shown that even small, incremental changes in food choices significantly improved dietary quality assessed by HEI-2005, meeting current dietary recommendations for key nutrients when averaged over seven days. Hornick et al. (2008) created a menu representative of the typical American diet, and used the HEI-2005 to assess dietary quality (Hornick, Krester, & Nicklas, 2008). The HEI-2005 score for this baseline menu of a typical American diet was 41. Transitional menus were subsequently created, gradually changing food group amounts and variety, and HEI-2005 scores increased incrementally by 13 points on average. For example, by adding one piece of fruit, substituting canned tuna in water for canned tuna in oil, and substituting 85% lean ground beef for 80% lean ground beef, total dietary quality of the meal increased by over 20 points using the HEI-2005. In conclusion, making small daily changes can dramatically increase the HEI-2005 score. The importance of these findings is magnified in light of the recent Institute of Medicine recommendation for all adults to have a total HEI-2005 ≥ 80 (Institute of Medicine, 2008).

Our findings differ from previous literature examining racial/ethnic differences in fruit and vegetable intake. Using a six-item food frequency questionnaire (FFQ), Neuhouser, Thompson, Coronado, and Solomon compared dietary intake among

Hispanic and NHW white residents of Washington State and found that Hispanic participants consumed one more serving of fruits and vegetables when compared to NHW participants (Neuhouser, Thompson, Coronado, & Solomon, 2004). Similarly, Thompson, Midthune, Subar, McNeel, Berrigan, and Kipnis found that fruit and vegetable intake, and fiber intake was highest among Latinos of both genders when compared to non-Latino whites and non-Latino black participants (Thompson et al., 2005). The data was collected during the 2000 National Health Interview Survey (NHIS) and a FFQ provided estimated intakes for fruits, vegetables, fiber, and percent energy from fat.

Our findings indicated no differences by ethnicity in percent energy from saturated fat and added calories from sugar, fat and alcohol. Similarly, Neuhouser, Thompson, Coronado, and Solomon (2004), and Kristal, Shattuck, and Patterson (1999) found no differences in fat intake when comparing Hispanic and NHW participants. In contrast, Murtaugh et al. used a diet history questionnaire to assess intake and found Hispanic participants consumed greater total energy, greater percent energy from fat, higher amounts of vegetable protein and lower overall protein and protein from animal sources when compared to NHW participants (Murtaugh et al., 2007).

All US adults are being encouraged by the Institute of Medicine to consume a healthy diet, as indicated by a total score of ≥ 80 on the Healthy Eating Index-2005 (IOM, 2008). However, in both 1994-1996 and 2001-2002, HEI-2005 scores for the US population were lower than recommendations for all components except total grains and meat and beans (Guenther et al., 2008a). Dark green and orange vegetables and legumes,

whole grains, sodium, and discretionary calories received the lowest scores. The US HEI-2005 estimates from NHANES data, collected from 2001 to 2002 by the National Center for Health Statistics (National Center for Health Statistics, 2007), are displayed in Table 3. Dietary intake was collected through an interviewer-assisted, 24-hour recall questionnaire. The NHANES data includes all persons aged two years and older with reliable dietary recalls ($n = 9,032$). Mean total HEI-2005 scores for Hispanic and NHW women in this study, and the US population scores (2001-2002) from NHANES data, were 47.0, 52.5, and 58.2 respectively. It is important to note that no single individual in the present study had a mean total HEI-2005 score ≥ 80 .

Diet quality has been assessed in other subpopulations. For example, McCabe-Sellers et al. assessed HEI scores among adults in the Lower Mississippi Delta region and found that overall diet quality was low, especially for grains, vegetables, fruit, dairy products, meats, and dietary variety (McCabe-Sellers et al., 2007). This study assessed diet quality using the HEI method prior to 2005 updates. Adults of the Lower Mississippi Delta with lower income and with less than a college education were only half as likely to have a healthy diet than were adults with a higher income and who had completed high school. A study utilizing South Carolina's BRFSS data reported similar associations between poor dietary practices and low income and educational attainment (Lu, Samuels, & Huang, 2002). In our study, 37% of the Hispanic participants and 57% of the NHW participants reported they were at least college graduates. Hence, the findings of this study are only generalizable to an educated population.

Several studies suggest that a healthful dietary pattern (as opposed to individual nutrient intakes), one that includes fruits and vegetables, high fiber, and reduced-fat dairy, is protective against weight gain and chronic disease (Carrera et al., 2007; McCullough et al., 2002; Newby et al., 2004). However, Carrera, Gao, and Tucker were unable to identify a healthful dietary pattern among Mexican-American participants in the NHANES 2001-2002 (Carrera et al., 2007). Instead, dietary patterns including poultry and alcohol, milk and baked products, traditional Mexican, and meat, were described. These patterns were based on the predominant foods that contributed relatively greater proportions of energy. Flavored, sweetened drinks were common to all four dietary patterns. Similar to our findings, subjects in each of the four dietary pattern groups obtained the lowest energy contributions from orange and green leafy vegetables. Using 7-day food records from participants in the Baltimore Longitudinal Study of Aging, a dietary pattern characterized by high fiber, reduced-fat dairy, and fruit was inversely associated with annual change in BMI and waist circumference, indicating a protective effect against weight gain (Newby et al., 2004). Similarly, using data from the Nurses Health Study, researchers found that women who consumed a diet with a high Alternative HEI (AHEI) score had a 28% reduced risk for CVD when compared to women consuming a diet with a low AHEI score (McCullough et al., 2002).

Markers of obesity, including waist circumference, total percent body fat, and percent trunk fat, were negatively correlated with total HEI-2005 scores among women in our study. Our findings are similar to the literature assessing the relationship between dietary quality and obesity. Guo et al. observed a significant increase in the likelihood of

obesity with descending HEI scores among men and women (Guo et al., 2004). The odds of being obese among men classified as having a poor diet was twice that of men classified as having a good diet. Individuals with poor dietary quality were younger, male, non-Hispanic black, smokers, and had a lower income and education level compared to other groups. In a prospective study, a dietary pattern with emphasis on reduced-fat dairy products, fruit, and fiber was inversely associated with body mass index (BMI) among women and waist circumference among both genders (Newby et al., 2004). Among women 60 years and older, those who had a BMI less than 30.0 kg/m² had higher mean total fat scores (indicating a lower intake) when compared to women with a BMI of 30 kg/m² or more (Ervin, 2008). Those with a BMI less than 25.0 kg/m² had higher mean dairy and overall HEI scores than those with a BMI of 30.0 kg/m² or more. Thus, in our studies and other studies, high dietary quality is associated with a lower risk of obesity.

Although income data was not collected, we did collect education data in this study. Thirty-seven percent of the Hispanic and 57% of the NHW participants in our study reported they were at least college graduates. Although HEI-2005 scores were not compared by education level in our analysis (due to a small sample size), understanding the influence of education and income on dietary choices is important. Both Guo (2004) and Hann (2001) observed lower dietary quality among participants of lower income level and educational attainment. Researchers found lower-quality diets among individuals with a high school education or less when compared to those with at least some college (Boynton, Neuhouser, Sorensen, McTiernan, & Ulrich, 2008). It is important to further evaluate dietary quality, via HEI-2005, among subpopulations in the

US to clarify inconsistent findings, to determine whether US populations are adhering to the 2005 Dietary Guidelines for Americans, and to further shape nutrition education and funding priorities.

Strengths of this study include the use of 7-day weighed food records, dietary analysis via the HEI-2005, and body composition analysis via DXA. There are several strengths associated with using 7-day weighed food records. Detailed intake data is provided and the records do not rely on memory. Further, multiple days are more representative of usual intake and the use of food scales is thought to be more accurate than relying on household measures (Lee & Nieman, 2003, pp 79-80). The HEI-2005 assesses dietary intake according to the key recommendations found in the 2005 Dietary Guidelines for Americans, and assesses intake adjusted for total energy intake in order to differentiate diet quality from diet quantity. It also addresses the consumption of energy-dense, nutrient-poor ingredients and foods; and focuses on the components that need to be improved the most among Americans: whole fruit, dark green and orange vegetables, legumes, whole grains, sodium, and discretionary calories. The DXA procedure requires little cooperation from the participant, is safe for adults (without current pregnancy), and is a quick procedure. Estimates of percent body fat from DXA have been found to be strongly correlated with those from underwater weighing (Lee & Nieman, 2003, pp 205-206).

The cross-sectional design of this research study precludes making causal inferences. Although food records are considered a typical method of dietary assessment, they may increase subject burden and require literacy. Furthermore, participants may

alter intake during the recording period. Food record analysis is also limited by the accuracy of the database of the Food Processor Nutrition and Fitness Software (version 8.5, 2005, ESHA Research, Salem, OR). Although we did assess education level of participants, we did not inquire information regarding annual income. However, education level has not only been the most commonly used measure of socioeconomic position, but it has also been suggested that education may be the best predictor of good health (Liberatos, Link, & Kelsey, 1988; Winkleby, Jatulis, Frank, & Fortmann, 1992). Future research should examine dietary quality in a larger sample size using 7-day food records. Increasing the sample size is a common method to improve the power of a statistical test. Other possibilities include additional validity testing, reliability testing, and adaptations of the HEI-2005 for specific subpopulations (Roubenoff et al., 1993). For example, the validity of the HEI-2005 for ethnic and cultural groups whose dietary intake may differ dramatically from that of the US population is yet to be determined. Additionally, research should pursue investigations of dietary quality, via HEI-2005, among populations of lower socioeconomic position. Increasing the evidence-based support and validity of using the HEI-2005 to assess dietary quality will help develop its use as an assessment tool, increasing the capability of using HEI-2005 components as predictors of chronic disease risk.

Conclusion

The Latino population (inclusive of individuals who self-identify as Hispanic) is the largest and fastest growing ethnic minority group in the US (US Census Bureau, 2006). Therefore, understanding the health trends of this population is important.

Assessment of dietary quality in a population is important to monitor adherence with dietary recommendations, to develop nutrition education, to design and evaluate nutrition interventions, and to direct public policy regarding nutrition. In this study, Hispanic women had lower total HEI-2005 scores, and lower scores for total vegetables, dark green and orange vegetables and legumes, and sodium when compared to NHW women. These findings may indicate that nutrition interventions among Arizona Hispanics should place emphasis on increasing vegetable consumption, especially dark green, orange, and legumes, and lowering sodium intake.

Tables

Table 1. Descriptive characteristics of Hispanic and non-Hispanic white women (N=74)

Characteristic	Hispanic Women (N=32)^a	Non-Hispanic White Women (N=42)^a	P-value
Age (y) ^d	29 ± 6	30 ± 6	0.46
Weight (kg)	74.7 ± 20.4	77.5 ± 20.2	0.55
Height (cm)	162.1 ± 6.3	166.7 ± 7.0	0.01*
Body Mass Index (kg/m ²)	28.3 ± 7.2	27.9 ± 7.3	0.80
Waist (cm)	89 ± 16	90 ± 13	0.81
Total body fat (%) ^b	41.1 ± 9.0	37.8 ± 10.5	0.15
Trunk fat (%) ^b	41.3 ± 8.3	37.2 ± 11.0	0.09
Education Level ^c			
Less than high school	0 (0)	0 (0)	
High school or equivalent	2 (6)	0 (0)	
Some college/technical school	17 (57)	20 (49)	
College graduate	5 (17)	12 (29)	
Post-baccalaureate	6 (20)	9 (22)	

^aAll values are mean ± standard deviation.

^bTotal body fat (%) and trunk fat (%) determined using dual-energy x-ray absorptiometry (DEXA). One NHW participant did not complete the DEXA.

^c Expressed as frequency and percent of total population in parentheses. Two H participants and one NHW participant did not provide this information.

* Test is significant at the 0.05 level.

Table 2. Reported energy and macronutrient intake of Hispanic and non-Hispanic white women (N=74)

Nutrient	Hispanic Women (N=32) ^{ab}	Non-Hispanic White Women (N=42) ^{ab}	Dietary Reference Intakes
Energy			
Kcal/d	1736 ±	1923 ± 496	
Kcal/kg body weight	564 24 ± 8	26 ± 8	
Protein			
g/d	70 ± 20	75 ± 18	
g/kg body weight	1.0 ± 0.3 17 ± 4	1.0 ± 0.3 16 ± 4	.8 ^c 10 – 35% ^c
% Energy			
Carbohydrate			
g/d	219 ± 81	245 ± 70	
g/kg body weight	3.0 ± 1.1 50 ± 7	3.3 ± 1.2 51 ± 8	45 – 65% ^c
% Energy			
Dietary sugar			
g/d	80 ± 38 18 ± 5	89 ± 32 19 ± 5	
% Energy			<25 ^c 25 ^c
Fiber (g/d)	17 ± 7	20 ± 9	
Total fat			
g/d	65 ± 24	72 ± 27	20 – 35% ^c
% Energy	34 ± 6	34 ± 7	
Saturated fat			
g/d	21 ± 8	24 ± 10	
% Energy	11 ± 3	11 ± 3	
Dietary cholesterol (mg)	216 ± 91	213 ± 100	< 200 mg ^c

^aAll values are mean \pm standard deviation.

^bIntake variables determined using 7-day food records analyzed with Food Processor®, version 8.5.

^cInstitute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids*. Washington, DC: The National Academies Press; 2002.

Table 3. HEI-2005 scores for Hispanic and non-Hispanic white women

Component	Maximum Score	Hispanic Women (N=32)	Non-Hispanic White Women (N=43)	P Value	US Population Scores (N=9,032) ^a
Total Fruit (cup) ^b	5	1.9 \pm 1.5	2.2 \pm 1.5	0.36	3.0
Whole Fruit (cup) ^c	5	1.8 \pm 1.7	2.3 \pm 1.6	0.18	3.4
Total Vegetables (cup) ^b	5	1.8 \pm 0.9	2.5 \pm 1.1	<0.05*	3.2
Dark Green and Orange Vegetables and Legumes (cups) ^c	5	0.4 \pm 0.5	1.0 \pm 1.1	<0.05*	1.4
Total Grains (oz) ^c	5	4.1 \pm 0.6	4.3 \pm 0.7	0.09	5.0
Whole Grains (oz) ^c	5	0.7 \pm 0.7	1.1 \pm 1.1	0.14	1.0
Milk (cup) ^b	10	3.8 \pm 2.1	4.3 \pm 2.4	0.36	6.3
Meat and Beans (oz) ^b	10	6.7 \pm 1.9	7.3 \pm 1.8	0.23	10.0
Oils (g) ^c	10	1.6 \pm 1.8	2.0 \pm 1.8	0.28	6.8
Sodium (g) ^b	10	3.0 \pm 1.7	3.7 \pm 1.4	<0.05*	6.4
Saturated Fat (% Energy) ^b	10	5.4 \pm 2.3	5.3 \pm 2.5	0.90	6.4
Calories from Solid Fat, Alcohol, and Added Sugar (% Energy) ^c	20	15.7 \pm 3.6	16.5 \pm 3.5	0.49	7.5
Total HEI-2005 Score ^b	100	47.0 \pm 9.9	52.5 \pm 11.8	<0.05*	58.2

^a Guenther PM, Juan WY, Reedy J, Britten P, Lino M, Carlson A, Hiza HH, Krebs-Smith SM. Diet quality of Americans in 1994-96 and 2001-02 as measured by the Healthy Eating Index-2005. Nutrition Insight 37. US Department of Agriculture, Center for Nutrition Policy and Promotion Web site.

<http://www.cnpp.usda.gov/Publications/NutritionInsights/Insigh37.pdf> Accessed September 1, 2008.

^b Independent T-test was performed to determine the difference between mean values.

^c Mann-Whitney U procedures were performed to determine the difference between mean values.

* Test is significant at the 0.05 level (2-tailed).

Table 4. Pearson Product-Moment Correlations between total Healthy Eating Index-2005 score and markers of obesity^a

Marker of obesity	Total HEI-2005 score correlation coefficient
Waist circumference (cm)	-0.271 (0.02)*
Total body fat (%) ^b	-0.288 (0.01)*
Trunk fat (%) ^b	-0.343 (0.003)*
Body mass index (kg/m ²)	-0.020 (0.08)

^aValues represent correlation coefficients with the significance level in parentheses.

^bTotal body fat (%) and trunk fat (%) determined using DEXA. One NHW participant did not complete the DEXA scan.

*P<0.05.

References

- Arizona Department of Health Services. (2007). Differences in the health status among race/ethnic groups, Arizona, 2007. Retrieved March 19th, 2009, from the Arizona Department of Health Services Official Website: <http://www.azdhs.gov/plan/report/dhsag/dhsag07/index.htm>.
- Basiotis, P.P., Carlson, A., Gerrior, S.A., Juan, W.Y., & Lino, M. (2002). The Healthy Eating Index: 1999-2000. CNPP-12. Retrieved September 1, 2008, from the US Department of Agriculture, Center for Nutrition Policy and Promotion Official Website: <http://www.cnpp.usda.gov/>
- Boynton, A., Neuhouser, M. L., Sorensen, B., McTiernan, A., & Ulrich, C. M. (2008). Predictors of diet quality among overweight and obese postmenopausal women. *Journal of the American Dietetic Association*, 108(1), 125-130. doi:10.1016/j.jada.2007.10.037
- Carrera, P. M., Gao, X., & Tucker, K. L. (2007). A study of dietary patterns in the mexican-american population and their association with obesity. *Journal of the American Dietetic Association*, 107(10), 1735-1742. doi:10.1016/j.jada.2007.07.016
- Coulston, A. M. (2001). The search continues for a tool to evaluate dietary quality. *The American Journal of Clinical Nutrition*, 74(4), 417.
- Daly, A., Evert, A., Franz, M.J. et al. (2008). *Choose Your Foods: Exchange Lists for Diabetes*. Alexandria, VA: American Diabetes Association.
- Ervin, R. B. (2008). Healthy eating index scores among adults, 60 years of age and over, by sociodemographic and health characteristics: United states, 1999-2002. *Advance Data*, (395)(395), 1-16.

- Ford, E. S., Will, J. C., De Proost Ford, M. A., & Mokdad, A. H. (1998). Health insurance status and cardiovascular disease risk factors among 50-64-year-old US women: Findings from the third national health and nutrition examination survey. *Journal of Women's Health / the Official Publication of the Society for the Advancement of Women's Health Research*, 7(8), 997-1006.
- Gao, S. K., Beresford, S. A., Frank, L. L., Schreiner, P. J., Burke, G. L., & Fitzpatrick, A. L. (2008). Modifications to the healthy eating index and its ability to predict obesity: The multi-ethnic study of atherosclerosis. *The American Journal of Clinical Nutrition*, 88(1), 64-69.
- Guenther, P.M., Juan, W.Y., Reedy, J., Britten, P., Lino, M., Carlson, A... Krebs-Smith, S. (2008a). Diet quality of Americans in 1994-96 and 2001-02 as measured by the Healthy Eating Index-2005. Nutrition Insight 37. US Department of Agriculture (USDA), Center for Nutrition Policy and Promotion. Retrieved September 1st, 2008, from the USDA, Center for Nutrition Policy and Promotion Official Website: <http://www.cnpp.usda.gov/Publications/NutritionInsights/>
- Guenther, P. M., Reedy, J., & Krebs-Smith, S. M. (2008b). Development of the healthy eating index-2005. *Journal of the American Dietetic Association*, 108(11), 1896-1901. doi:10.1016/j.jada.2008.08.016
- Guenther, P. M., Reedy, J., Krebs-Smith, S. M., & Reeve, B. B. (2008c). Evaluation of the healthy eating index-2005. *Journal of the American Dietetic Association*, 108(11), 1854-1864. doi:10.1016/j.jada.2008.08.011
- Guo, X., Warden, B. A., Paeratakul, S., & Bray, G. A. (2004). Healthy eating index and obesity. *European Journal of Clinical Nutrition*, 58(12), 1580-1586. doi:10.1038/sj.ejcn.1601989
- Hann, C. S., Rock, C. L., King, I., & Drewnowski, A. (2001). Validation of the healthy eating index with use of plasma biomarkers in a clinical sample of women. *The American Journal of Clinical Nutrition*, 74(4), 479-486.
- Hornick, B. A., Krester, A. J., & Nicklas, T. A. (2008). Menu modeling with MyPyramid food patterns: Incremental dietary changes lead to dramatic improvements in diet quality of menus. *Journal of the American Dietetic Association*, 108(12), 2077-2083. doi:10.1016/j.jada.2008.09.010
- Institute of Medicine of the National Academies. Food and Nutrition Board. (2002). Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington, D.C.: National Academies Press.

- Institute of Medicine of the National Academies. (2008). State of the USA Health Indicators: Letter Report. Washington, D.C.: National Academies Press. Retrieved January 15, 2009 from the Institute of Medicine of the National Academies Official Website: <http://www.iom.edu/>
- Kennedy, E. T., Ohls, J., Carlson, S., & Fleming, K. (1995). The healthy eating index: Design and applications. *Journal of the American Dietetic Association*, 95(10), 1103-1108. doi:10.1016/S0002-8223(95)00300-2
- Kristal, A. R., Shattuck, A. L., & Patterson, R. E. (1999). Differences in fat-related dietary patterns between black, hispanic and white women: Results from the women's health trial feasibility study in minority populations. *Public Health Nutrition*, 2(3), 253-262.
- Larkey, L. K., Day, S. H., Houtkooper, L., & Renger, R. (2003). Osteoporosis prevention: Knowledge and behavior in a southwestern community. *Journal of Community Health*, 28(5), 377-388.
- Lee, R.D., & Nieman, D.C. (2003). Measuring Diet. In *Nutritional Assessment* (3rd Ed), pp. 79-80.
- Lee, R.D., & Nieman, D.C. (2003). Anthropometry. In *Nutritional Assessment* (3rd Ed). pp. 205-206.
- Liberatos, P., Link, B. G., & Kelsey, J. L. (1988). The measurement of social class in epidemiology. *Epidemiologic Reviews*, 10, 87-121.
- Lu, N., Samuels, M. E., & Huang, K. C. (2002). Dietary behavior in relation to socioeconomic characteristics and self-perceived health status. *Journal of Health Care for the Poor and Underserved*, 13(2), 241-257.
- McCabe-Sellers, B. J., Bowman, S., Stuff, J. E., Champagne, C. M., Simpson, P. M., & Bogle, M. L. (2007). Assessment of the diet quality of US adults in the lower Mississippi delta. *The American Journal of Clinical Nutrition*, 86(3), 697-706.
- McCullough, M. L., Feskanich, D., Stampfer, M. J., Giovannucci, E. L., Rimm, E. B., Hu, F. B., Spiegelman, D., Hunter, D. J., Colditz, G. A., & Willett, W. C. (2002). Diet quality and major chronic disease risk in men and women: Moving toward improved dietary guidance. *The American Journal of Clinical Nutrition*, 76(6), 1261-1271.

- Mokdad, A. H., Serdula, M. K., Dietz, W. H., Bowman, B. A., Marks, J. S., & Koplan, J. P. (1999). The spread of the obesity epidemic in the United States, 1991-1998. *JAMA : The Journal of the American Medical Association*, 282(16), 1519-1522.
- Murtaugh, M. A., Herrick, J. S., Sweeney, C., Baumgartner, K. B., Guiliano, A. R., Byers, T., & Slattery, M. L. (2007). Diet composition and risk of overweight and obesity in women living in the southwestern United States. *Journal of the American Dietetic Association*, 107(8), 1311-1321.
doi:10.1016/j.jada.2007.05.008
- National Center for Chronic Disease Prevention and Health Promotion. (2007). Behavioral Risk Factor Surveillance System. Prevalence and Trends: fruits and vegetables. Retrieved April 9, 2009, from the National Center for Chronic Disease Prevention and Health Promotion Official Website:
<http://apps.nccd.cdc.gov/BRFSS/list.asp?cat=FV&yr=2007&qkey=4415&state=Al>
- National Center for Health Statistics. (2007). National Health and Nutrition Examination Survey 2001-2002. Documentation, Codebook, and Frequencies: Dietary Interview. Retrieved October 1, 2008 from the Center for Disease Control and Prevention Official Website: <http://www.cdc.gov/nchs/nhanes.htm>
- Neuhouser, M. L., Thompson, B., Coronado, G. D., & Solomon, C. C. (2004). Higher fat intake and lower fruit and vegetable intakes are associated with greater acculturation among Mexicans living in Washington state. *Journal of the American Dietetic Association*, 104(1), 51-57. doi:10.1016/j.jada.2003.10.015
- Newby, P. K., Muller, D., Hallfrisch, J., Andres, R., & Tucker, K. L. (2004). Food patterns measured by factor analysis and anthropometric changes in adults. *The American Journal of Clinical Nutrition*, 80(2), 504-513.
- Ogden, C. L., Carroll, M. D., Curtin, L. R., McDowell, M. A., Tabak, C. J., & Flegal, K. M. (2006). Prevalence of overweight and obesity in the United States, 1999-2004. *JAMA : The Journal of the American Medical Association*, 295(13), 1549-1555.
doi:10.1001/jama.295.13.1549
- Ogden, C. L., Carroll, M. D., McDowell, M. A., & Flegal, K. M. (2007). Obesity among adults in the United States--no statistically significant change since 2003-2004. *NCHS Data Brief*, (1)(1), 1-8.
- Patterson, R. E., Haines, P. S., & Popkin, B. M. (1994). Diet quality index: Capturing a multidimensional behavior. *Journal of the American Dietetic Association*, 94(1), 57-64.

- Roubenoff, R., Kehayias, J. J., Dawson-Hughes, B., & Heymsfield, S. B. (1993). Use of dual-energy x-ray absorptiometry in body-composition studies: Not yet a "gold standard". *The American Journal of Clinical Nutrition*, 58(5), 589-591.
- Thompson, F. E., Midthune, D., Subar, A. F., McNeel, T., Berrigan, D., & Kipnis, V. (2005). Dietary intake estimates in the national health interview survey, 2000: Methodology, results, and interpretation. *Journal of the American Dietetic Association*, 105(3), 352-63; quiz 487. doi:10.1016/j.jada.2004.12.032
- US Census Bureau. (2006). Nation's population one-third minority. Retrieved October 2, 2008 from the US Census Bureau Official Website: <http://www.census.gov/Press-Release/www/releases/archives/population /006808.html>
- Winkleby, M. A., Jatulis, D. E., Frank, E., & Fortmann, S. P. (1992). Socioeconomic status and health: How education, income, and occupation contribute to risk factors for cardiovascular disease. *American Journal of Public Health*, 82(6), 816-820.

Chapter 3

The Positive Relationship Between Screen Time (TV, Computer)

And Markers Of Obesity In Women

Abstract

Sedentary behaviors have been positively associated with obesity. Television viewing represents a popular sedentary behavior; the average household watches over 8 hours/day. This study examined the relationship between screen time (ST; TV and computer time) and obesity. Women (20-40y; n=81) completed height, weight, waist circumference, and percent body fat assessments; fat mass index (FMI; fat mass [kg]/height [m²] and waist/height ratio (WHtR) were calculated. Leptin concentrations were determined from blood samples. Participants recorded time spent in sedentary behaviors and physical activity for 7 days. Obesity and ST were examined using partial correlations (controlling for age, parity, physical activity), and ANCOVA. Reported physical activity was used as a covariate. Total screen, TV, and computer time were positively associated with body mass index (BMI), waist circumference, WHtR, FMI, total body fat, and leptin. BMI, waist circumference, WHtR, FMI, and leptin were significantly lower among those reporting the lowest ST (<3 hours/day) versus the moderate (3-5 hours/day) and high (>5 hours/day) ST groups. These findings support new guidelines for Americans to reduce sedentary behavior and screen time.

Introduction

Defined by a body mass index (BMI) of greater than or equal to 30 kg/m^2 , obesity varies by age and sex, and by race-ethnic group among adult women (Ogden, Yanovski, Carroll, & Flegal, 2007). In 2007-2008, the obesity prevalence among adult men and women residing in the US was approximately 32.2% and 35.5% respectively (Flegal, Carroll, Ogden, & Curtin, 2010). Although the increases in obesity prevalence observed in the past decade do not appear to be continuing at the same rate, obesity remains a public health problem (Ogden, Carroll, McDowell, & Flegal, 2007).

In an attempt to reverse the obesity epidemic, the Centers for Disease Control and Prevention (2009a) have emphasized the importance of achieving at least 150 minutes of moderate-intensity aerobic activity each week, 75 minutes of vigorous-intensity aerobic activity each week, or an equivalent mix of both. The recommendation was generated from mounting evidence suggesting that this minimum level of physical activity is necessary to lower risk for obesity and co-morbid weight-related health problems. Additional benefits, such as lowering the risk for coronary heart disease, stroke, hypertension, type 2 diabetes mellitus, and colon and breast cancer, can be accrued by engaging in five hours of moderate-intensity physical activity each week, or two hours and 30 minutes of vigorous intensity physical activity each week [US Department of Health and Human Services (USDHHS), 2009].

In addition to the recommendation to engage in regular physical activity, emerging evidence suggests a need to promote a reduction in sedentary behaviors, such as overall sitting time and television viewing (Hamilton, Healy, Dunstan, Zderic, &

Owen, 2008; USDHHS, 1996). Television viewing is a highly prevalent sedentary behavior among youth and adults in the US, as the average household spends over eight hours per day watching television (Nielsen Media Research, 2007). On average, the adult male spends 29 hours per week watching television, while the adult female spends 34 hours per week (Nielsen Media Research, 1998). Further, the amount of computer usage by adults has dramatically risen (Kominski & Newburger, 1999). In 1984, only 18% of the adult population reported using a computer, however, by 1997, nearly half of the adult population reported using a computer. In contrast to television viewing time, adult men and women do not differ in the reported amount of computer use. The increasing prevalence of computer use and ownership, and the lack of research addressing the influence of time spent using the computer on markers of obesity, warrants further investigation into the possible obesogenic influence of this popular sedentary behavior.

Screen Time and Markers of Obesity

Television viewing and obesity have increased in parallel over the past decade (Egger & Swinburn, 1997; Nielsen Media Research, 2009). Leading to reduced energy expenditure, television viewing displaces physical activity and results in a lower metabolic rate when compared with other sedentary behaviors (Ainsworth et al., 1993; McCarthy, Gibney, & Flynn, 2002). Recent epidemiological investigations have suggested a pronounced positive association between time spent viewing television and obesity-related anthropometric measurements such as body mass index (BMI; kg/m^2) and waist circumference (Healy et al., 2008; Jakes et al., 2003; Kronenberg et al., 2000; Stamatakis, Kirani, & Rennie, 2009; Thorp et al., 2010). The National Heart, Lung, and

Blood Institute's Family Heart Study was a population-based, multi-center study that suggested that television viewing had a significant positive association with BMI, waist circumference, waist-to-hip ratio, and skin fold thickness (subscapular and triceps) (Kronenberg et al., 2000). The observed associations were more pronounced among women than in men. Data from the European Prospective Investigation into Cancer (EPIC) study (1993-1997) found that watching ≥ 4 hours/day of television was associated with an age-adjusted BMI of approximately 2.0 units greater, when compared to watching ≤ 2 hours/day (Jakes et al., 2003). Analyses from both the 1999-2000 and 2004-2005 Australian Diabetes, Obesity, and Lifestyle (AusDiab) study reported an association between television viewing time and waist circumference, and the association was again more pronounced among women (Healy et al., 2008; Thorp et al., 2010). A significant, detrimental dose-response association was found between television viewing time and waist circumference in the analysis of the 1999-2000 data (Healy et al., 2008); while the 2004-2005 study analysis reported a detrimental effect of television viewing time on both waist circumference and BMI (Thorp et al., 2010).

Analysis of the 2003 Scottish Health Survey supports the notion that television viewing is independently related to obesity, regardless of the amount of physical activity engagement. In this study, participants reported time spent watching television, using the computer, and playing video games, and height, weight, and waist circumference were measured (Stamatakis et al., 2009). Participants reporting ≥ 4 hours/day of screen time (television, computer, and video game use) were more likely to have a BMI ≥ 30 kg/m² and a waist circumference indicative of obesity (≥ 88 cm in women and ≥ 102 cm in men).

The prevalence of obesity remained high for participants who met physical activity recommendations but reported ≥ 4 hours/day of screen time.

Healthy People 2020 (USDHHS, 2009) and the Center for Disease Control and Prevention (CDC, 2009b) Recommended Community Strategy support guidelines on limiting the amount of screen time (use of television, computer, and video games) among children to no more than 2 hours per day. Similar guidelines for adults have not yet been established. However, the Dietary Guidelines Advisory Committee recently released their report regarding the development of the Dietary Guidelines 2010, and included recommendations to limit screen time among adults. Therefore, the present study examined the relationship between reported time spent in screen time (TV and computer time) and markers of obesity [body mass index (kg/m^2 ; BMI), waist-to-height ratio (WHtR), total body fat (percent), fat mass index (kg/m^2 ; FMI), trunk fat /leg fat, and serum leptin concentration (ng/ml)] among young, premenopausal women. This analysis included reported physical activity (min/day) as a covariate to investigate the independent effect of screen time on markers of obesity.

The null hypothesis for this study is that there are no differences in key markers of obesity BMI (kg/m^2), WHtR, total body fat (percent), FMI (kg/m^2), trunk fat /leg fat (percent), and serum leptin concentrations (ng/ml) when comparing women divided into screen time (TV + computer) categories. Our study population was limited to women for two primary reasons: (1) Epidemiologic investigations have suggested that positive associations between anthropometric measurements and screen time may be more pronounced among women when compared to men, and (2) women appear to engage in

more time watching television (Nielsen Media Research, 1998; Kronenberg et al., 2000; Healy et al., 2008; Thorp et al., 2010). Novel markers of obesity, WHtR, FMI (kg/m^2), and trunk fat/leg fat ratio, were included in our analysis because their use may improve coronary heart disease prediction and result in fewer misclassifications for overweight and obese (Ashwell, 2009; Cox & Whichelow, 1996; Kelly, Wilson, & Heymsfield; 2009). FMI is based on actual fat mass, as opposed to BMI, which is based on the use of body weight (which accounts for both fat and lean tissue) (Kelly et al., 2009). WHtR has been reported as a better predictor of coronary heart disease than BMI and waist circumference, to a lesser degree (Ashwell, 2009). Finally, trunk fat/leg fat ratio is a good indication of fat distribution, in addition to fat mass (Kelly et al., 2009).

Methods

Study Design

A cross-sectional study was conducted at Arizona State University in Mesa, Arizona between September 2007 and May 2008. The study was designed to investigate the relationship between reported screen time (TV and computer time) and markers of obesity. The study was approved by the Arizona State University Institutional Review Board.

Study Participants and Recruitment

Participants in this study included a convenience sample of premenopausal women residing in the Phoenix Metropolitan area. Study recruitment began in October 2007 and women were recruited through the university, civic organizations, community centers, and local churches. Women who responded to recruitment flyers were

encouraged to call the study researchers to obtain additional information and complete an initial telephone screening interview. Study inclusion criteria consisted of the following: BMI between 18.5 and 39.9 kg/m²; between 20 and 40 years of age; weight stable (no weight fluctuation of 10% or more in the past 6 months); nonsmoker (defined by no use of cigars, cigarettes, or other tobacco products in the past 6 months); regular menstruation (defined by at least 10 periods in the past year); not currently being treated for cancer, liver disease, kidney disease, gallbladder disease, or gastrointestinal malabsorption; and no pregnancy, lactation, or uncontrolled thyroid disorder in the past year. Eighty-eight participants were included in the study. Five were found to have a BMI outside of the eligible range, two did not complete activity records, and four did not complete a DEXA scan, therefore 77 were included in this analysis. Participants were provided with information regarding their body composition and leptin concentration after the study was completed.

Procedure

Participants completed 3 study visits. At the first visit, research participants signed a written consent form and completed a health history questionnaire. Participants were also asked to complete a 7-day activity log to record how much time was spent watching television, using the computer, playing electronic games, reading, and performing physical activity. At the second visit, height, weight, and waist circumference were measured. A fasting blood sample was also collected to measure leptin concentration. At the third visit, body composition was determined by dual energy x-ray absorptiometry (DEXA) (GE Lunar Prodigy Pro, Madison, WI).

Assessment of Screen Time

Participants were asked to complete a 7-day activity record. This record included how much time was spent watching television, using the computer, playing electronic games, reading, and performing physical activity. Averages were determined and screen time (TV and computer use) categories were derived from this data. Participants were classified into three screen time categories (<3 hours/day, 3-5 hours/day, >5 hours/day). Categories were developed reflective of those used in the literature. Participants of this study did not report playing electronic games; therefore, total screen time was limited to TV and computer use. Reported physical activity (min/day) was used as the covariate in the analysis.

Assessment of Obesity

Anthropometrics. Participant height, weight, and waist circumference were measured at the second visit. Height was measured (without shoes) to the nearest 0.1 cm, using a stadiometer (Seca Corporation; Ontario, CA) with the subject's back against the wall. The subject's weight was measured to the nearest 0.1 kg using a Seca digital scale (Seca Corporation; Ontario, CA). BMI (kg/m^2) was calculated using the subject's height (m) and weight (kg). Participant waist circumference was measured in triplicate using a non-stretchable Gullick II measuring tape (Country Technology; Gay Mills, WI) to the nearest 0.1 cm, at the level of the iliac crest.

Body composition. Whole body DEXA exams were completed by a certified technician according to the procedures recommended by the manufacturer. Total body fat (percent), trunk fat (percent), and leg fat (percent) were determined by a DEXA scan (GE

Lunar Prodigy Pro, Madison, WI). Participants were asked to refrain from consuming a calcium-containing supplement for eight hours prior to the DEXA scan and to wear loose clothing with no metal components. They were asked to remove all jewelry and other personal effects that could interfere with the DEXA exam. Procedures included having the participant rest in the incumbent position for 10 to 30 minutes while they received a full body scan with low-intensity x-rays.

Calculated reference variables. Several calculations were made using the anthropometric and DEXA measurements: WHtR [waist (cm)/height (cm)], fat mass index [FMI; fat mass/height²; (kg/m²)], and trunk fat/leg fat ratio. Waist/height ratio was determined by dividing participant waist circumference (cm) by participant height (cm). The WHtR has been proposed as a way of assessing body shape and monitoring risk for weight-related conditions (Ashwell, 2009). Prospective studies have suggested that waist circumference and WHtR are better than BMI at predicting deaths from coronary heart disease, and WHtR is a slightly better predictor than using waist circumference alone (Cox & Whichelow, 1996; Lu, Ye, Adami, & Weiderpass, 2006). Waist/height ratios above 0.5 indicate increased risk for both males and females (Cox & Whichelow, 1996).

Fat mass index (FMI) was determined by dividing DEXA-determined fat mass (kg) by height² (m²). The use of FMI increases specificity when compared to using BMI alone because FMI is based on actual fat mass, not body weight (which accounts for both fat and lean tissue) (Kelly, Wilson, and Heymsfield, 2009). Optimal FMI values for women are between 5-9 kg/m² (Kelly et al. 2009). There is increasing agreement that fat distribution may be as important as total fat mass, therefore, two measurements of fat

mass distribution were included in the investigation: trunk fat/leg fat ratio and waist circumference (cm).

Leptin Concentration. Leptin, a hormone produced and secreted from white adipose tissue, primarily functions in the regulation of appetite and energy expenditure (Milewicz, Mikulski, & Bidzinska, 2000). In general, as the lipid content increases within the adipocytes, the production and secretion of leptin increases, decreasing appetite and increasing energy expenditure. When adipocytes are lacking in lipid, leptin concentration is reduced. After an overnight (8-hour) fast, participant blood was drawn to analyze serum leptin concentrations. Serum leptin concentrations were run in duplicate in the nutrition laboratory at Arizona State University by radioimmunoassay (Linco, St. Charles, MO).

Power Calculations and Statistical Analysis

Eighty-eight participants were included in the study. Five were found to have a BMI outside of the eligible range, two did not complete activity records, and four did not complete a DEXA scan, therefore 77 were included in this analysis. Sample size calculations were based on change in percent body fat. With the assumption of a SD of 7, a sample of 25 women per weight group [normal weight (BMI=18.5-24.9 kg/m²), overweight (BMI=25-29.9 kg/m²), or obese (BMI=30-39.9 kg/m²)] was estimated to provide $\geq 80\%$ power at a 5% level of significance to detect a 28% difference in percent body fat.

Statistical analyses were performed using SPSS (version 17.0, 2008, SPSS Institute Inc, Chicago, IL). Preliminary analyses were performed to ensure no violation of

the assumptions of normality, linearity, and homoscedascity. To account for skewed distribution, time spent viewing television (min/day) and time spent using the computer (min/day) were transformed by the square root. One-way analysis of variance (ANOVA) compared sample characteristics by weight category [normal weight (BMI=18.5-24.9 kg/m²), overweight (BMI=25-29.9 kg/m²), or obese (BMI=30-39.9 kg/m²)]. A *post hoc* pairwise multiple comparison procedure compared differences in sample characteristics by weight category. Corrections were made for multiple comparisons according to the Bonferonni method; α was set at 0.017 (0.05/3).

Partial correlation explored the relationship between screen time (TV, computer use, and total screen time) and markers of obesity [waist circumference, WHtR, FMI (kg/m²), total body fat (percent), trunk fat/leg fat ratio, and serum leptin concentration (ng/dl)], while controlling for age, parity, and reported physical activity (min/day). One-way analysis of covariance (ANCOVA) compared markers of obesity by screen time categories (<3 hours/day, 3-5 hours/day, and >5 hours/day). Reported physical activity (min/day) was used as a covariate in this analysis. A *post hoc* pairwise multiple comparison procedure compared differences in sample characteristics by screen time category. Corrections were made for multiple comparisons according to the Bonferroni method.

Results

Eighty percent of the study participants reported Caucasian/non-Hispanic white ethnicity, 7% reported black/African American ethnicity, and 6% reported Hispanic/Latino ethnicity. Table 1 shows the sample characteristics of 77 female

participants (mean age 32 ± 5 , WHtR 0.5 ± 0.1 , BMI $27.9 \pm 5.7 \text{ kg/m}^2$) categorized by BMI group. Forty-eight percent of the participants had at least a college degree.

Descriptive Characteristics by BMI Category

An omnibus ANOVA showed significant differences by BMI category for waist circumference (cm), WHtR ($p < 0.001$), FMI (kg/m^2 ; $p < 0.001$), total body fat (percent; $p < 0.001$), trunk fat/leg fat ratio ($p < 0.05$), leptin (ng/dl; $p < 0.001$), computer use (min/day; $p < 0.01$), and total screen time (TV + computer min/day; $p < 0.01$) (Table 1). For waist circumference (cm), WHtR, FMI (kg/m^2), total body fat (percent), and leptin (ng/dl), all BMI categories were significantly different, with lower levels among those women in a lower BMI group. Participants in the overweight category had a significantly higher trunk fat/leg fat ratio when compared to participants in the normal weight category ($p < 0.01$). Participants in the obese weight category spent significantly more time using the computer ($p < 0.05$) and had a significantly greater total screen time ($p < 0.01$) when compared to those in the normal weight category.

Associations Between Screen Time and Markers of Obesity

Partial correlation explored the relationship between screen time (TV, computer, and total) and markers of obesity [BMI (kg/m^2), waist circumference, WHtR, FMI (kg/m^2), total body fat (percent), trunk fat/leg fat ratio, and serum leptin concentration (mg/dl)], while controlling for age, parity, and reported physical activity (min/day) (Tables 2 and 3). We observed positive, partial correlations between total screen time and markers of obesity, [BMI: $r = 0.39$, $p < 0.01$; waist circumference: $r = 0.41$, $p < 0.001$; WHtR: $r = 0.43$, $p < 0.001$; FMI: $r = 0.37$, $p < 0.01$; total body fat (percent): $r = 0.34$, $p < 0.01$; leptin:

$r=0.40$, $p<0.001$] (Table 2). An inspection of the zero order correlation suggested that controlling for age, parity, and reported physical activity (min/day) had very little effect on the strength of the positive associations.

There were also positive, partial correlations between TV time and BMI ($r=0.30$; $p<0.05$); waist circumference ($r=0.35$; $p<0.05$), WHtR ($r=0.32$; $p<0.01$), FMI ($r=0.31$; $p<0.01$), total body fat (percent) ($r=0.31$; $p<0.01$), and leptin ($r=0.40$; $p<0.001$), with high TV time associated with greater values for obesity-related measurements (Table 3). An inspection of the zero order correlation suggested that controlling for age, parity, and reported physical activity (min/day) had very little effect on the strength of the relationship between TV time and markers of obesity.

Positive, partial correlations existed between computer time and BMI ($r=0.29$; $p<0.05$); waist circumference ($r=0.31$; $p<0.01$), WHtR ($r=0.36$; $p<0.01$), FMI ($r=0.28$; $p<0.05$), total body fat (percent) ($r=0.26$; $p<0.05$), and leptin ($r=0.28$; $p<0.05$) (Table 3). An inspection of the zero order correlation suggested that controlling for age, parity, and reported physical activity (min/day) had very little effect on the strength of the relationship between computer use and markers of obesity.

Markers of Obesity by Total Screen Time Category

A one-way between-groups ANCOVA explored the impact of screen time on obesity markers (Table 4). Reported physical activity (min/day) was used as the covariate in this analysis. Participants were classified into three total screen time categories (<3 hours/day, 3-5 hours/day, >5 hours/day). There were statistically significant group differences for BMI [$F(2, 78)=6.0$, $p=0.004$, partial eta squared=0.14], waist

circumference [F (2, 78)=6.7, p=0.002, partial eta squared=0.16], WHtR [F (2, 78)=8.5, p=0.000, partial eta squared=0.19], FMI [F (2, 78)=5.1, p=0.009, partial eta squared=0.12], total body fat [F (2, 78)=3.5, p=0.036, partial eta squared=0.09], and leptin [F (2, 78)=5.2, p=0.008, partial eta squared=0.12]. Participants in the lowest screen time category (<3 hours/day) had a significantly lower BMI (p=0.028), waist circumference (0.006), WHtR (p=0.002), FMI (p=0.041), and leptin concentration (p=0.022), when compared to participants in the moderate screen time category (3-5 hours/day). Participants in the lowest screen time category (<3 hours/day) had a significantly lower BMI (p=0.007), waist circumference (p=0.012), WHtR (p=0.003), FMI (p=0.018), and leptin concentration (p=0.027), when compared to participants in the highest screen time category (>5 hours/day).

Discussion

Adoption of an active lifestyle, characterized by viewing ≤ 10 hours/week of television and engaging in ≥ 30 minutes/day of physical activity, has been associated with a 30% reduction of obesity cases (Hu, Li, Colditz, Willett, & Manson, 2003). Recent studies have reported that television viewing may play a role in the development of obesity (Healy et al., 2008; Stamatakis et al., 2009; Thorp et al., 2010). Possible mechanisms include: (1) television viewing leads to reduced energy expenditure by displacing the opportunity for physical activity; and (2) results in a lower metabolic rate compared with other sedentary behaviors (Jakes et al., 2003; Milewicz et al., 2000; USDHHS, 2009). However, recent investigations have also suggested that television viewing may impact obesity and obesity-related markers independently of engagement in

physical activity. Further, the use of computers and electronic games has greatly increased in the past decade, therefore, these screen behaviors need to be examined in addition to television viewing (Kominski & Newburger, 1999).

Body composition

Our data emphasize that time spent engaged in screen time behaviors, such as television viewing and computer use, is an important and modifiable risk factor for obesity. A key finding of this study was the significant, positive association observed between total screen time and BMI, waist circumference, WHtR, FMI, total body fat (percent), and leptin concentration. In line with previous research (Healy et al., 2008; Kronenberg et al., 2000; Thorp et al., 2010), we observed significant, positive associations between time spent viewing television and BMI, waist circumference, and total body fat (percent). Adding to the current literature, we also found significant positive associations between time spent viewing television and novel markers of obesity, WHtR and FMI. Use of these novel markers of obesity may improve coronary heart disease prediction and result in fewer misclassifications for overweight and obese (Ashwell, 2009; Cox & Whichelow, 1996; Kelly et al., 2009). Similar associations were observed between computer use and selected markers of obesity. Although a positive association was observed between trunk fat/leg fat ratio and screen time variables, the association did not reach statistical significance. When examining total screen time, television time, and computer use, adjustments made for age, parity, and reported physical activity (min/day) had very little effect on the strength of the associations,

suggesting that screen time may have an independent effect on selected markers of obesity.

Our findings extend the literature (Jakes et al., 2003; Thorp et al., 2010) showing an increased prevalence of markers of obesity among participants who engaged in over 5 hours of total screen time (television and computer use) per day when compared to those who engaged in less than 3 hours per day. In the present study, participants in the highest screen time category (≥ 5 hours/day) had a significantly higher BMI, waist circumference, WHtR, FMI, and leptin concentration when compared to participants in the lowest screen time category (≤ 3 hours/day). Participants in the moderate screen time category (3-5 hours/day) had a significantly higher BMI, waist circumference, WHtR, and leptin concentration when compared to those in the lowest screen time category (≤ 3 hours/day). Interestingly, there was a greater difference between the low and moderate screen time categories for waist circumference, WHtR, and leptin concentration when compared to the corresponding differences between the low and high screen time categories.

As previously mentioned, the positive associations observed between screen time and BMI, waist circumference, WHtR, FMI, total body fat (percent), and leptin concentration were not effected when adjustments were made for age, parity, and reported physical activity (min/day), perhaps suggesting that screen time may have an independent effect on selected markers of obesity. Similarly, all selected markers of obesity, with the exception of total body fat (percent) and trunk fat/leg fat ratio, were significantly lower among the low screen time group, and this difference remained significant after using reported physical activity (min/day) as a covariate. Similar findings

were reported by analysis of the 2003 Scottish Health Survey. The prevalence of obesity among individuals who engaged in ≥ 4 hours of television viewing per day but met physical activity recommendations still remained high, suggesting that time spent viewing television may exert an independent effect on obesity. In our sample, after using reported physical activity (min/day) as a covariate, a strong relationship existed between screen time and BMI (partial eta squared=0.14), waist circumference (partial eta squared=0.16), and WHtR (partial eta squared=0.19); and a moderately strong relationship between screen time and total body fat (partial eta squared=0.09), FMI (partial eta squared=0.12), and leptin (partial eta squared=0.13). Therefore, screen time accounted for nearly 14% of the variance in BMI, 16% of the variance in waist circumference, and 20% of the variance observed in WHtR.

Leptin concentration

There is a strong correlation between adiposity measures and leptin concentration in obese humans (Milewicz et al., 2000). Obese subjects consistently display significantly higher leptin concentration when compared to lean subjects. Our data support previous research in finding significant differences in leptin concentration by BMI category. The results of our study also indicate a positive association between total screen time (TV + computer hours/day), television time, and computer use and leptin concentration. Also, leptin concentrations were significantly lower among participants in the lowest screen time category when compared to those in both moderate and high screen time categories. This observation remained statistically significant after using reported physical activity (min/day) as a covariate. Similarly, Fung et al. (2000) examined the associations between

time spent watching television and plasma biomarkers of obesity and found that the average time spent watching television per week was positively associated with leptin concentrations.

The present study has several strengths that make it unique to the current body of research. Body composition was assessed by DEXA. The DEXA procedure requires little cooperation from the participant, is safe for adults (without current pregnancy), and is considered the gold standard for body composition analysis. Estimates of percent body fat from DEXA have been found to be highly correlated with those from underwater weighing (Lee & Nieman, 2003). It has been suggested that use of novel markers of obesity, such as WHtR, FMI (kg/m^2), and trunk fat /leg fat (percent), result in fewer weight misclassifications and also have a stronger predictability for coronary heart disease (Ashwell, 2009; Cox & Whichelow, 1996; Kelly et al., 2009). Therefore, they were included in our analysis. Our assessment of sedentary behavior, total screen time, included both time spent watching television and using a computer. Lastly, we were able to account for reported physical activity (min/day) to investigate whether screen time affected markers of obesity, independent of physical activity.

The cross-sectional design of this research study precludes making causal inferences. We were unable to differentiate between recreational and work-related computer use. Also, because the study population was free-living, we did not control for dietary intake. Participants were instructed to follow their usual diet. Future research should examine the influence of screen time on obesity and obesity-related health conditions in a larger sample size. Although we initially recruited 25 overweight

participants, one participant was excluded from analysis because she did not complete the DEXA scan, and two did not complete a 7-day activity record. Increasing the sample size is a common method to improve the power of a statistical test. Lastly, the sample was restricted to women, therefore, generalization to men or women of other age ranges is questionable. A gender-by-screen time interaction may be significant and future research should examine such behaviors among men.

Conclusion

In summary, the findings of many recent studies support the call for the promotion of guidelines limiting screen time among adults. Our findings and those of other studies have reported a higher BMI, waist circumference, and total body fat (percent) among individuals who engage in more time in front of the television and computer. Our findings also suggest that greater than 3 hours of screen time deleteriously influences markers of obesity among premenopausal women, independent of reported physical activity. Therefore, there is a need for policy to address screen time among adult populations. As well as meeting daily physical activity guidelines, populations should aim to reduce time spent in front of the screen to fewer than 3 hours/day. In addition to the guidelines limiting screen time among children, recommendations limiting screen time among adults should be instated, especially among women of child-bearing age and parents, so they may set a good example for their children. The Dietary Guidelines Advisory Committee report recently suggested that the Dietary Guidelines 2010 include recommendations for adults to limit screen time behaviors and to avoid eating while watching television (USDA, 2010).

Tables

Table 1. Characteristics of the study population as categorized by body mass index

Variable	Body Mass Index Category ^a				F*	P value
	Overall ^a (n=77)	Normal (n=28)	Overweight (n=22)	Obese (n=27)		
Age (yr)	32 ± 5	31 ± 5	30 ± 4	35 ± 4		
Height (cm)	167 ± 7	166 ± 6	170 ± 8	167 ± 8		
Weight (kg)	78 ± 18	61 ± 6 ^ψ	78 ± 8 ^φ	96 ± 12 ^ζ	94.6	0.000
Waist Circumference (cm) ^b	91 ± 14	77 ± 8 ^ψ	92 ± 6 ^φ	105 ± 9 ^ζ	92.1	0.000
Waist/Height Ratio ^c	0.54 ± 0.08	0.47 ± 0.05 ^ψ	0.54 ± 0.04 ^φ	0.63 ± 0.06 ^ζ	72.9	0.000
Fat Mass Index (kg/m ²) ^d	12 ± 5	7 ± 2 ^ψ	11 ± 2 ^φ	17 ± 2 ^ζ	165.6	0.000
Total Body Fat (%) ^e	40 ± 9	32 ± 6 ^ψ	41 ± 6 ^φ	48 ± 4 ^ζ	72.9	0.000
Trunk Fat/Leg Fat ^e	0.94 ± 0.11	0.90 ± 0.13 ^ψ	0.99 ± 0.11	0.95 ± 0.07 ^ψ	4.8	0.011
Leptin (ng/dl) ^f	19 ± 16	8 ± 4 ^ψ	16 ± 7 ^φ	32 ± 20 ^ζ	55.8	0.000
Television Use (min/day)	101 ± 68	80 ± 57	100 ± 53	125 ± 81	2.5	0.092

Computer Use (min/day)	181 ± 135	135 ± 90 ^ψ	170 ± 135	240 ± 157 ^ζ	4.1	0.021
Total Screen Time (TV + computer use)	248 ± 145	190 ± 106 ^ψ	236 ± 124	317 ± 169 ^ζ	6.1	0.003

^aAll values are mean ± standard deviation.

^bOptimal waist circumference in women ≤88 cm.

^cRatio of waist circumference to height. Optimal ratio <0.50. (Ashwell, M., & Hsieh, S.D., 2005).

^dFat Mass Index (fat mass/height²). Optimal range for females 5-9 kg/m². (Kelly, T.L., Wilson, K.E., & Heymsfield S.B., 2009).

^eTotal body fat (percent), trunk fat (Percent), and leg fat (percent) determined using dual energy x-ray absorptiometry (DEXA).

^fNormal value in lean women 7.4 ± 3.7 (BMI = 18-25 kg/m²) (Linco, Inc.).

^φP values for pairwise comparisons provided; significance of post-hoc pairwise comparison with Bonferonni adjustment (p<0.017).

*df=2,74 using one-way analysis of variance.

**Different superscripts within the same row indicate significant differences.

Table 2. Pearson product-moment correlations and partial correlations between total screen time and markers of obesity (n=77)

Markers of Obesity	<u>Total Screen Time^a</u>		
	Pearson Correlation	Partial Correlation ^b	Partial Correlation ^c
Body Mass Index (kg/m ²)	0.43 (0.000)	0.41 (0.000)	0.39 (0.001)
Waist Circumference (cm) ^d	0.41 (0.000)	0.43 (0.000)	0.41 (0.000)
Waist/Height Ratio ^e	0.44 (0.000)	0.45 (0.000)	0.43 (0.000)
Fat Mass/Height ² (kg/m ²) ^f	0.41 (0.000)	0.39 (0.000)	0.37 (0.001)
Total Body Fat (%) ^g	0.36 (0.002)	0.36 (0.001)	0.34 (0.004)
Trunk Fat/Leg Fat ^g	0.15 (0.180)	0.13 (0.278)	0.13 (0.289)
Leptin (ng/dl) ^h	0.42 (0.000)	0.43 (0.000)	0.40 (0.000)

^a Values represent correlation coefficients with the significance level in parentheses; ^b Partial correlation controlling for age and parity; ^c Partial correlation controlling for age, parity and reported physical activity (min/day); ^d Optimal waist circumference in women ≤ 88 cm; ^e Ratio of waist circumference to height. Optimal ratio < 0.50 . (Ashwell, M., & Hsieh, S.D., 2005); ^f Fat Mass Index (fat mass/height²). Optimal range for females 5-9 kg/m². (Kelly, T.L., Wilson, K.E., & Heymsfield S.B., 2009) ; ^g Total body fat (percent), trunk fat (percent), and leg fat (percent) determined using dual energy x-ray absorptiometry (DEXA); ^h Normal value in lean women 7.4 ± 3.7 (BMI = 18-25 kg/m²) (Linco, Inc.); * P value significant at the $p > 0.05$ level.

Table 3. Pearson product-moment correlations and partial correlations between television viewing and computer use and markers of obesity (n=77)

Markers of Obesity	Television Viewing ^a			Computer Use ^a		
	Pearson Correlation	Partial Correlation ^b	Partial Correlation ^c	Pearson Correlation	Partial Correlation ^b	Partial Correlation ^c
Body Mass Index (kg/m ²)	0.35 (0.002)	0.33 (0.004)	0.30 (0.011)	0.33 (0.004)	0.29 (0.011)	0.29 (0.011)
Waist Circumference (cm) ^d	0.39 (0.001)	0.39 (0.000)	0.35 (0.002)	0.30 (0.009)	0.30 (0.009)	0.31 (0.008)
Waist/Height Ratio ^e	0.36 (0.002)	0.36 (0.002)	0.32 (0.006)	0.35 (0.002)	0.35 (0.002)	0.36 (0.002)
Fat Mass/Height ² (kg/m ²) ^f	0.37 (0.001)	0.36 (0.002)	0.31 (0.007)	0.30 (0.008)	0.27 (0.017)	0.28 (0.016)
Total Body Fat (%) ^g	0.36 (0.001)	0.36 (0.002)	0.31 (0.008)	0.26 (0.020)	0.25 (0.031)	0.26 (0.027)
Trunk Fat/Leg Fat ^g	0.10 (0.367)	0.09 (0.459)	0.08 (0.476)	0.14 (0.238)	0.11 (0.333)	0.11 (0.339)
Leptin (ng/dl) ^h	0.44 (0.000)	0.44 (0.000)	0.40 (0.000)	0.28 (0.013)	0.27 (0.018)	0.28 (0.016)

^aValues represent correlation coefficients with the significance level in parentheses.

^bPartial correlation controlling for age and parity.

^cPartial correlation controlling for age, parity and reported physical activity (min/day).

^dOptimal waist circumference in women ≤ 88 cm.

^eRatio of waist circumference to height. Optimal ratio < 0.50 . (Ashwell, M., & Hsieh, S.D., 2005).

^fFat Mass Index (fat mass/height²). Optimal range for females 5-9 kg/m². (Kelly, T.L., Wilson, K.E., & Heymsfield S.B., 2009).

^gTotal body fat (percent), trunk fat (percent), and leg fat (percent) determined using dual energy x-ray absorptiometry (DEXA).

^hNormal value in lean women 7.4 ± 3.7 (BMI = 18-25 kg/m²) (Linco, Inc.).

*P value significant at the $p > 0.05$ level.

Table 4. Markers of obesity as categorized by total screen time (television and computer use) using physical activity (min/day) as a covariate (n=77)

Markers of Obesity	Total Screen Time Category ^a			F ^{**}	P value	Paired Comparisons [*]		
	<3 h/d (Low) (n=31)	3-5 h/d (Mod) (n=21)	>5 h/d (High) (n=25)			Low/Mod	Low/High	Mod/High
Body Mass Index (kg/m ²)	25.3 ± 4.5	29.6 ± 6.1	29.9 ± 5.3	6.0	0.004	0.028	0.007	1.000
Waist Circumference (cm) ^b	84 ± 12	97 ± 15	95 ± 11	6.7	0.002	0.006	0.012	1.000
Waist/Height Ratio ^c	0.50 ± 0.07	0.58 ± 0.09	0.57 ± 0.07	8.5	0.000	0.002	0.003	1.000
Fat Mass/Height ² (kg/m ²) ^d	10 ± 4	13 ± 5	13 ± 4	5.1	0.009	0.041	0.018	1.000
Total Body Fat (%) ^e	37 ± 9	42 ± 9	42 ± 8	3.5	0.036	0.126	0.061	1.000
Trunk Fat/Leg Fat ^e	0.93 ± 0.12	0.95 ± 0.12	0.96 ± 0.09	0.6	0.532	1.000	0.789	1.000
Leptin (ng/dl) ^f	12.0 ± 8.0	24.7 ± 20.7	22.0 ± 16.8	5.2	0.008	0.022	0.027	1.000

^a All values are mean ± standard deviation.

^b Optimal waist circumference in women ≤88 cm.

^c Ratio of waist circumference to height. Optimal ratio <0.50.

^d Fat Mass Index (fat mass/height²). Optimal range for females 5-9 kg/m².

^e Total body fat (percent), trunk fat (percent), and leg fat (percent) determined using dual energy x-ray absorptiometry (DEXA).

^f Normal value in lean women 7.4 ± 3.7 (BMI = 18-25 kg/m²) (Linco Inc.).

· P values for pairwise comparisons provided; p values reflect Bonferonni adjustment for multiple comparisons.

**df=2,74 using one-way analysis of variance.

References

- Ainsworth, B.A., Haskell, W.L., Leon, A.S., Jacobs, D.R. Jr., Montoye, H.J., Sallis, J.F., & Paffenbarger, R.S. Jr. (1993). Compendium of physical activities: classification of energy costs of human physical activities. *Medicine & Science in Sports & Exercise*, 25(1), 71-80. Retrieved April 13, 2010, from Medicine & Science in Sports & Exercise Official Website: <http://journals.lww.com/acsm-msse>
- Ashwell, M., & Hsieh, S.D. (2005). Six reasons why the waist-to-height ratio is a rapid and effective global indicator for health risks of obesity and how its use could simplify the international public health message on obesity. *International Journal of Food Sciences and Nutrition*, 56(5), 303-307. doi:0963-7486
- Ashwell, M. (2009). Obesity risk: importance of the waist-to-height ratio. *Nursing Standard*, 23(41), 49-54. Retrieved April 1, 2010, from Nursing Standard Official Website: <http://nursingstandard.rcnpublishing.co.uk/>
- Centers for Disease Control and Prevention (2009a). 2008 Physical activity guidelines for Americans. Fact sheet for health professionals on physical activity guidelines for adults. Retrieved April 1, 2010, from Centers for Disease Control and Prevention Official Website: http://www.cdc.gov/nccdphp/dnpa/physical/health_professionals/reports/index.htm
- Centers for Disease Control and Prevention. (2009b). Morbidity and Mortality Weekly Report (MMWR): Recommended community strategies and measurements to prevent obesity in the United States. Retrieved April 13, 2010, from Centers for Disease Control and Prevention Official Website: <http://www.cdc.gov/mmwr>
- Cox, B.D., & Whicelow, M. (1996). Ratio of waist circumference to height is better predictor of death than body mass index. *British Medical Journal*, 313(7070), 1487. Retrieved April 13, 2010, from British Medical Journal Official Website: <http://www.bmj.com>
- Egger, G., & Swinburn, B. (1997). An "ecological" approach to the obesity pandemic. *BMJ (Clinical Research Ed.)*, 315(7106), 477-480.
- Flegal, K.M., Carroll, M.D., Ogden, C.L., & Curtin, L.R. (2010). Prevalence and trends in obesity among US adults, 1999-2008. *JAMA: Journal of the American Medical Association*, 303(3), 235-241. doi:10.1001
- Fung, T. T., Hu, F. B., Yu, J., Chu, N. F., Spiegelman, D., Tofler, G. H., Willett, W. C., & Rimm, E. B. (2000). Leisure-time physical activity, television watching, and

plasma biomarkers of obesity and cardiovascular disease risk. *American Journal of Epidemiology*, 152(12), 1171-1178.

- Hamilton, M.T., Healy, G.N., Dunstan, D.W., Zderic, T.W., & Owen, N. (2008). Too little exercise and too much sitting: Inactivity physiology and the need for new recommendations on sedentary behavior. *Current Cardiovascular Risk Reports*, 2, 292-298. doi:10.1007
- Healy, G.N., Dunstan, D.W., Salmon, J., Shaw, J.E., Zimmet, P.Z., & Owen, N. (2008). Television time and continuous metabolic risk in physically active adults. *Medicine & Science in Sports & Exercise*, 40(4), 639-645. doi:10.1249
- Hu, F.B., Li, T.Y., Colditz, G.A., Willett, W.C., & Manson, J.E. (2003). Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA: Journal of the American Medical Association*, 289, 1785-1791. doi:10.1001
- Jakes, R.W., Khaw, K.T., Luben, R., Oakes, S., Welch, A., Bingham, S., & Wareham, N.J. (2003). Television viewing and low participation in vigorous recreation are independently associated with obesity and markers of cardiovascular disease risk: EPIC-Norfolk population-based study. *European Journal of Clinical Nutrition*, 57, 1089-1096. doi:10.1038
- Kelly, T.L., Wilson, K.E., & Heymsfield, S.B. (2009). Dual energy x-ray absorptiometry body composition reference values from NHANES. *PLoS ONE*, 4(9), e7038. doi:10.1371
- Kesaniemi, Y.K., Danforth, E. Jr., Jensen, M.D., Kopelman, P.G., Lefebvre, P., & Reeder, B.A. (2001). Dose-reponse issues concerning physical activity and health: an evidence-based symposium. *Medicine & Science in Sports & Exercise*, 33(6), S351-358. Retrieved April 1, 2010, from the Medicine & Science in Sports & Exercise Official Website: <http://journals.lww.com/acsm-msse/pages/default.aspx>
- Kominski, R., & Newburger, E. (1999). Access denied: Changes in computer ownership and use: 1984-1997. Population Division US Census Bureau Washington, D.C. Retrieved April 1, 2010, from the US Census Bureau Official Website: <http://www.census.gov/>
- Kronenberg, F., Pereira, M.A., Schmitz, K.H., Arnett, D.K., Evenson, K.R., Crapo, R.O... Hunt, S.C. Influence of leisure time physical activity and television watching on atherosclerosis risk factors in the NHLBI family heart study. *Atherosclerosis* 2000, 153:433-443. doi:10.1016

- Lee, R.D., & Nieman, D.C. (2003). Anthropometry. In *Nutritional Assessment* (3rd Ed), pp. 205-206. New York: McGraw-Hill.
- Lu, M., Ye, W., Adami, H.O., & Weiderpass, E. (2006). Prospective study of body size and risk for stroke amongst women below age 60. *Journal of Internal Medicine*, 260(5), 442-450. doi:10.1111
- McCarthy, S.N., Gibney, M.J., & Flynn, A. (2002). Irish Universities Nutrition Alliance: Overweight, obesity, and physical activity levels in Irish adults: evidence from the North/South Ireland food consumption survey. *Proceedings of the Nutrition Society*, 61(1), 3-7. doi:10.1079
- Milewicz, A., Mikulski, E., & Bidzinska, B. (2000). Plasma insulin, cholecystokinin, galanin, neuropeptide Y and leptin levels in obese women with and without type 2 diabetes mellitus. *International Journal of Obesity*, 24, S152-S153. Retrieved April 13, 2010, from the International Journal of Obesity Official Website: <http://www.nature.com/ijo/index.html>
- Nielsen Media Research. (1998). Nielsen report on television, Nielsen Media Research. New York: Nielsen Media Research, AC Nielsen. Retrieved September 1, 2010, from Nielsen Media Research Official Website: <http://en-us.nielsen.com/tab/industries/media>
- Nielsen Media Research. (2007). Nielsen reports television tuning remains at record levels, digital video recorders grow in popularity. New York: Nielsen Media Research, AC Nielsen. Retrieved September 1, 2010, from Nielsen Media Research Official Website: <http://en-us.nielsen.com/tab/industries/media>
- Nielsen Media Research. (2009). A2/M2 three screen report, vol 4-6. New York: Nielsen Media Research, AC Nielsen. Retrieved September 1, 2010, from Nielsen Media Research Official Website: <http://en-us.nielsen.com/tab/industries/media>
- Ogden, C. L., Carroll, M. D., McDowell, M. A., & Flegal, K. M. (2007). Obesity among adults in the united states--no statistically significant change since 2003-2004. *NCHS Data Brief*, (1)(1), 1-8.
- Ogden, C.L., Yanovski, S.Z., Carroll, M.D., & Flegal, K.M. (2007). The epidemiology of obesity. *Gastroenterology*, 132, 2087-2102. doi:10.1053/j.gastro.2007.03.052
- Stamatakis, E., Kirani, V., & Rennie, K. (2009). Moderate-to-vigorous physical activity and sedentary behaviours in relation to body mass index-defined and waist circumference-defined obesity. *British Journal of Nutrition*, 101(5), 765-73. doi:10.1017

- Thorp, A. A., Healy, G. N., Owen, N., Salmon, J., Ball, K., Shaw, J. E., Zimmet, P. Z., & Dunstan, D. W. (2010). Deleterious associations of sitting time and television viewing time with cardiometabolic risk biomarkers: Australian diabetes, obesity and lifestyle (AusDiab) study 2004-2005. *Diabetes Care*, 33(2), 327-334. doi:10.2337/dc09-0493
- US Department of Agriculture. (2010). Dietary Guidelines for Americans. Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2010. Retrieved June 15th, 2010, from the US Department of Agriculture Official Website: <http://www.cnpp.usda.gov/DGAs2010-DGACReport.htm>.
- US Department of Health and Human Services. (1996). Physical activity and health: a report of the Surgeon General. Atlanta, Georgia: US Department of Health and Human Services, CDC. Retrieved April 13, 2010, from Centers for Disease Control and Prevention Official Website: <http://www.cdc.gov/nccdphp/sgr/index.htm>
- US Department of Health and Human Services. (2009). Developing healthy people 2020: Physical activity and fitness. Atlanta, Georgia: US Department of Health and Human Services, CDC. Retrieved December 15, 2010, from the US Department of Health and Human Services Official Website: www.hhs.gov

Chapter 4

Dietary Intake During Screen Time Among Premenopausal Women

Abstract

Dietary intake and snacking during television watching could exacerbate the deleterious effects that are already associated with television watching. The present study examined the relationship between television and computer screen time and dietary intake in a sample of healthy women. 82 female participants (mean age 32 ± 4 y, waist/height ratio 0.5 ± 0.1 , BMI 27.7 ± 5.7 kg/m²) were categorized into screen time groups. Methods included 7-day weighed food records, activity records, height, weight, waist circumference, and body composition assessment. Absolute intake and the proportion of intake consumed during screen time were computed for the following variables: total fat, saturated fat, sugar, fiber, calcium, vitamin C, and snacking. One-way ANOVA compared total dietary intake among the three screen time categories. Non-parametric tests were used to compare the proportion of dietary intake consumed during screen time by screen time category, and to determine whether differences existed in energy, fat, sugar, and nutrient density among foods consumed during television viewing compared to computer use. Participants in the highest screen time category had the highest BMI and waist/height ratio. There were no significant differences in absolute dietary intake by screen time category. There were statistically significant differences at the $p < 0.01$ level in the proportion of dietary intake consumed during screen time variables for the three groups. Participants in the lowest screen time category consumed a significantly lower proportion of total energy, total fat, saturated fat, fiber, and calcium

($p < 0.001$) during screen time when compared to participants in the moderate and high screen time categories. Participants in the lowest screen time category consumed less sugar (Low/Mod: $p = 0.006$) and vitamin C (Low/Mod: $p = 0.006$) during screen time when compared to those in the moderate screen time category; and fewer snacks (Low/High: $p = 0.000$) when compared to those in the highest screen time category. Participants consumed a significantly greater percent of energy from fat ($p = 0.036$) and saturated fat ($p = 0.041$) during television viewing when compared to computer use. The findings of this study support the creation of guidelines that limit screen time usage among adults.

Introduction

The prevalence of obesity has dramatically increased over the past 30 years (Ogden et al., 2006). Obesity rates doubled between 1980 and 2004 among adults living in the United States (US). Recent estimates indicate that 33% of US adults are overweight (body mass index [BMI] ≥ 25.0 kg/m²), 34% are obese (BMI ≥ 30.0 kg/m²), and 6% are extremely obese (BMI ≥ 40.0 kg/m²) (Ogden et al., 2006; Ogden, Carroll, McDowell, & Flegal, 2007). Now considered a pandemic, the increased prevalence of obesity is not limited to the US but has also increased in many countries (James, 1992).

Physical inactivity (sedentary behavior) is considered a risk factor for obesity and obesity-related diseases [US Department of Health and Human Services (USDHHS), 1996]. Among adults, positive associations have been observed between television viewing and snacking frequency, obesity (BMI and percent body fat), waist circumference, systolic blood pressure, triglycerides, glucose, insulin, and overall risk for type 2 diabetes; and negative associations have been observed between television viewing and cardiorespiratory fitness and high-density lipoprotein-cholesterol (Bennett et al., 2006; Bowman, 2006; Gore, Foster, DiLillo, Kirk, & Smith West, 2003; Healy et al., 2008; Hu, Li, Colditz, Willett, & Manson, 2003; Johnson, Nelson, & Bradley, 2006; Kronenberg et al., 2000; Pettee, Ham, Macera, & Ainsworth, 2009; Stamatakis, Hirani, & Rennie, 2009). Television viewing represents a popular sedentary behavior; the average household watches over eight hours of television per day (Nielsen Media Research, 2007). Television viewing and obesity rates have increased in parallel, and television viewing may play a role in the development of obesity (Nielsen Media Research, 2007;

Nielsen Media Research, 2009; Egger & Swinburn, 1997). Television viewing leads to reduced energy expenditure by displacing the opportunity for physical activity and resulting in a lower metabolic rate compared with other sedentary behaviors (Ainsworth et al., 1993; Coon, Goldberg, Rogers, & Tucker, 2001; Hetherington, 2007; McCarthy, Gibney, Flynn, & Irish Universities Nutrition Alliance, 2002).

Several studies have shown that the association between television viewing and obesity-related measurements and health risks are independent of leisure time physical activity levels, supporting the notion that television viewing may promote obesity through effects on energy intake (Healy et al., 2008; Hu et al., 2003; Kronenberg et al., 2000; Stamatakis et al., 2009). Television viewing is associated with increased snacking (Gore et al., 2003; Thomson, Spence, Raine, & Laing, 2008), and there are two primary mechanisms by which television viewing may promote increased dietary intake through. First, it has been shown that exposure to advertisements may stimulate the desire to consume a specific type of food, such as fast food, juice, breakfast cereals, snack cakes, and candy (Borzekowski & Robinson, 2001; Chamberlain, Wang, & Robinson, 2006; Young, 2003). Second, television distracts individuals from satiety and food disappearance cues, resulting in increased food intake (Hetherington, 2007).

Unfortunately, limited research has examined dietary behaviors during television viewing among adults. Bowman found differences in total energy intake among three television-viewing categories (<1 hours/day; 1-2 hours/day; >2 hours/day) (Bowman, 2006). Adults (aged 20 years and older) in this study participated in the US Department of Agriculture's Continuing Survey of Food Intakes by Individuals (1994-1996). Those

who watched more than two hours of television per day consumed more energy, total fat, carbohydrate, and protein, and consumed significantly less dietary fiber, when compared to adults who watched less than two hours per day. Other research has shown significant positive associations between eating while watching television and obesity, total energy intake, and fat intake (Gore et al., 2003; Johnson et al., 2006). Using a food frequency questionnaire and a questionnaire to assess time spent watching television and videos, Gore et al. investigated whether consuming snacks and meals in front of the television was associated with total energy and fat intake among overweight women (Gore et al., 2003). Snacking in front of the television was correlated with total energy and fat intake, however, consuming meals in front of the television was not correlated with energy or fat intake.

Though prior studies of sedentary activity and obesity have focused on television viewing, Americans (particularly youth) now allocate a substantial proportion of their time to recreational computer use (Fulton et al., 2009). Given that individuals are less likely to be exposed to food advertisements, and more mentally engaged during recreational computer use, it is unclear whether computer use would show similar associations with food intake as television viewing.

Purpose

The American Academy of Pediatrics, Healthy People 2020, and the Centers for Disease Control and Prevention (CDC) Recommended Community Strategy proposed guidelines on limiting the amount of screen time (use of television, computer, and video games) among children to no more than two hours per day (CDC, 2009; USDHHS,

2009). Recently, the Dietary Guidelines Advisory Committee released a report recommending adults to also limit the amount of time spent engaged in screen time behaviors [US Department of Agriculture (USDA), 2010].

The present study examined the relationship between television and computer screen time and dietary intake in a sample of healthy women. Seven-day weighed food records and activity logs (time spent in sedentary behaviors) were collected from young healthy women. Dietary intake was characterized in terms of total daily dietary intake (snacks, energy, fat, saturated fat, sugar, fiber, calcium, and vitamin C), nutrition composition of foods consumed (percent fat, percent saturated fat, percent sugar, fiber density, calcium density, and vitamin C density), and proportion of intake consumed during total, television, and computer screen time. Fiber, calcium, and vitamin C were included in the investigation because they are important nutrients that are commonly consumed below recommendations. We also examined associations of adiposity measures with screen time but they were not a focus of the analysis and are described elsewhere. The null hypotheses for this investigation are:

there would be no group differences by screen time category for (1) daily consumption of snacks; (2) daily consumption of total energy, fat (g/d; % energy), saturated fat (g/d; % energy), and sugar (g/d; % energy); (3) daily consumption of total nutrients such as fiber (g/d), calcium (mg/d), and vitamin C (mg/d); (4) daily percent of total energy, fat (g/d), saturated fat (g/d), and sugar (g/d) intake *during* screen time; and (5) percent of total nutrient [fiber (g/d), calcium (mg/d), and vitamin C (mg/d)] consumption occurring *during* screen time. Lastly (6), the foods consumed during television viewing would not

differ from foods consumed during computer use in energy, fat (g/d; % energy), saturated fat (g/d; % energy), sugar (g/d; % energy), fiber (g/d; g/1000 kcal), calcium (mg/d; mg/1000 kcal), and vitamin C (mg/d; mg/1000 kcal).

Methods

Participants

A convenience sample of premenopausal women was recruited through flyers posted within the Greater Phoenix, Arizona area. Interested participants were encouraged to call the study researchers to obtain more information and complete an initial telephone screening interview. Women were included in the study if they fit the following criteria: BMI between 18.5 and 39.9 kg/m²; between 20 and 40 years of age; weight stable (no weight fluctuation of 10% or more in the past 6 months); nonsmoker (defined by no use of cigars, cigarettes, or other tobacco products in the past 6 months); regular menstruation (defined by at least 10 periods in the past year); not currently being treated for cancer, liver disease, kidney disease, gallbladder disease, or gastrointestinal malabsorption; and no pregnancy, lactation, or uncontrolled thyroid disorder in the past year. Premenopausal women were chosen as the study population to minimize confounding biological factors associated with menopause that might influence adiposity. Further, limiting screen time among adults should especially be communicated to women of child-bearing age and parents so they may set a good example for their children. Physical activity was not screened during recruitment, and therefore not part of the exclusion/inclusion criteria. Of the 88 eligible participants who were initially recruited, five were found to have a BMI outside of the eligible range, and one did not complete a

dietary record. Eighty-two participants completed the entire study protocol. The study was approved by the Arizona State University Institutional Review Board. Participants were provided with information regarding their dietary intake and body composition after the study was completed.

Procedure

Participants completed two study visits. At the first visit, research participants signed a written consent form and completed a health history questionnaire. They also received training in the completion of weighed food records, and were asked to record all foods and beverages (except water) for 7 consecutive days following the 1st study visit. Participants were provided with a small, food scale (Metrokane Gourmet Weigh®) and practiced weighing foods. Food record forms also contained columns to document whether a food/beverage was consumed as a main meal, snack, or beverage only, and the primary activity completed while eating (watching television, using the computer, socializing, driving, and sitting quietly). Participants were reminded to record all foods and beverages, including condiments and items added to food, such as salt, sugar, and cream; and were encouraged to record the brand, preparation method, and amount. Participants were also provided with an activity record to be completed at the end of each day (described below). Written instructions were given to participants to take home.

At the second visit, height, weight, and waist circumference were measured (described below). Additionally, study researchers reviewed participants' weighed food records and queried participants to address any ambiguous or incomplete entries.

Measures

Anthropometry. Height was measured to the nearest 0.1 cm using a Seca 214 stadiometer (Seca Corporation; Ontario, CA). Weight was measured to the nearest 0.1 kg using a Seca Bella 840 digital scale (Seca Corporation; Ontario, CA). BMI (kg/m^2) was calculated using participant height (m) and weight (kg). Waist circumference was measured in triplicate to the nearest 0.1 cm using a Gulick II measuring tape (County Technology, Inc., Gay Mills, WI) at the level of the iliac crest (Lee & Nieman, 2007) while the participant was fasting. Total percent body fat was determined by BIA (Bioelectrical Impedance Analysis) using the Bodystat QuadScan (Bodystat Limited, Douglas, Isle of Man, British Isles). Two electrodes were placed on the wrist and two were placed on the ankle of the non-dominant side of the body. A safe battery-generated current (50 kHz) was passed through the body and the resistance to this charge was measured by the instrument (Lee & Nieman, 2007).

Waist/height ratio was determined by dividing participant waist circumference (cm) by participant height (cm). The WHtR has been proposed as a way of assessing body shape and monitoring risk for weight-related conditions (Ashwell, 2009). Prospective studies have suggested that waist circumference and WHtR are better than BMI at predicting deaths from coronary heart disease, and WHtR is a slightly better predictor than using waist circumference alone (Cox & Whicelow, 1996; Lu, Ye, Adami, & Weiderpass, 2006). Waist/height ratios above 0.5 indicate increased risk for both males and females (Cox & Whicelow, 1996).

Screen time. Participants were asked to complete an activity record at the end of each day. This record included how much time was spent watching television, using the

computer, playing electronic games, reading, and performing programmed physical activity. Screen time categories were derived from these data. Participants were classified into three television viewing categories (<1 h/d, 1-2 h/d, >2 h/d), three computer use categories (<1.5 h/d, 1.5-3.5 h/d, >3.5 h/d), and three total screen time categories (<3 h/d, 3-5 h/d, >5 h/d). Categories were developed so that participants were equally distributed and reflective of those used in the literature.

Dietary intake. Dietary intake was analyzed using Food Processor SQL (ESHA, Salem, OR). Average daily intake of snacks (occasions per day), total energy, total fat (grams), saturated fat (grams), sugar (grams), fiber (grams), calcium (milligrams), and vitamin C (milligrams) were computed for each participant. Fiber, calcium, and vitamin C were included in the analysis because they are important nutrients that are often consumed below recommendations. Calcium intake can reflect bone health, a concern among women of child-bearing age, and vitamin C reflects antioxidant status. Several variables were computed from the nutrition and activity measures. These variables include the percentage of energy (kcal), fat (g/d; % energy), saturated fat (g/d; % energy), sugar (g/d; % energy), fiber (g/d; g/1000 kcal), calcium (mg/d; mg/1000 kcal), and vitamin C (mg/d; mg/1000 kcal), and number of snacks consumed during total screen time, television viewing, and computer use.

Snacks. The number of snacks consumed was calculated as the average number of entries (food or beverage) per day self-reported as “snacks” on weighed food records. Snacking during screen time included only snacks consumed during television and/or

computer use, and was displayed as both an absolute value and a percentage of total snack intake.

Statistical Analysis

The sample was based on the differences between active and sedentary women in terms of fiber intake (g/day). A sample of 24 participants (per group) was estimated to provide >80% power at a 5% level of significance.

Statistical analyses were performed using SPSS (version 17.0, 2008, SPSS Institute Inc, Chicago, IL). One-way ANOVA was used to compare sample characteristics and total dietary intake by screen time categories (<3 hours/day, 3-5 hours/day, and >5 hours/day). A *post hoc* pairwise multiple comparison procedure was used to compare differences in sample characteristics by screen time category. Corrections were made for multiple comparisons according to the Bonferonni method; α was set at 0.017 (0.05/3).

The Kolmogorov-Smirnov tests of normality were violated for all variables describing dietary intake consumed *during* screen time (total, television, and computer); therefore, medians, 25th, and 75th percentiles are displayed to summarize the data. The Kruskal-Wallis Test compared the percentage of energy, fat, saturated fat, sugar, fiber, calcium, and vitamin C consumed *during* screen time by screen time category. Mann-Whitney U tests compared pairs of groups and a Bonferonni adjustment was applied to correct the alpha values for multiple comparisons; α was set at 0.017 (0.05/3).

The final analysis sought to determine whether differences exist in energy, fat, sugar, and nutrient density among foods consumed during television viewing compared

to computer use. The Wilcoxon Signed Rank Test was utilized to assess the within subjects differences in dietary intake consumed during the two different conditions; α was set at 0.05.

Results

Eighty percent of the study participants reported Caucasian/non-Hispanic white ethnicity, 7% reported black/African American ethnicity, and 6% reported Hispanic/Latino ethnicity. Table 1 shows the sample characteristics of 82 female participants categorized by screen time (mean age 32 ± 4 , waist/height ratio 0.5 ± 0.1 , BMI $27.7 \pm 5.7 \text{ kg/m}^2$). Forty-six percent of the participants had at least a college degree.

Associations of Adiposity Measures With Screen Time

The data displayed a clear trend in BMI and body composition measures, with those who engaged in the least amount of screen time having more optimal values than those who engaged in the highest amount of screen time. A one-way between groups ANOVA showed significant differences by screen time category for BMI ($p=0.010$), waist/height ratio ($p=0.002$), and percent body fat ($p=0.021$). Participants who spent more than 5 hours/day in total screen time had a significantly greater BMI when compared to those who spent <3 hours/day in total screen time ($p=0.010$); and waist/height ratio was significantly lower among those who spent <3 hours/day in total screen time compared to both those who spent more than 5 hours/day ($p=0.006$), and those who spent 3-5 hours/day in total screen time ($p=0.009$). Although the ANOVA showed a significant group difference for percent body fat, the significance did not remain after adjusting the p value for multiple comparisons.

Total Dietary Intake by Screen Time Category

A one-way between groups ANOVA was conducted to explore the impact of total screen time on total dietary intake (snacks, energy, total fat, saturated fat, sugar, fiber, calcium, and vitamin C). There were no significant differences for any of the dependent total dietary intake variables by screen time category (Table 2).

Percent of Dietary Intake That Occurred During Screen Time

When the percent of total dietary intake variables consumed during total screen time was compared among the three screen time groups, statistically significant differences at the $p < 0.01$ level in all dependent variables were observed (Table 3). Participants in the lowest screen time category (<3 hours/day) consumed significantly fewer snacks during screen time (Low/Mod: $p = 0.023$; Low/High: $p = 0.000$) and a lower percentage of energy (kcal; Low/Mod: $p = 0.000$; Low/High: $p = 0.000$), fat (grams; Low/Mod: $p = 0.000$; Low/High: $p = 0.000$), saturated fat (grams; Low/Mod: $p = 0.001$; Low/High: $p = 0.000$), fiber (grams; Low/Mod: $p = 0.000$; Low/High: $p = 0.000$), calcium (milligrams; Low/Mod: $p = 0.000$; Low/High: $p = 0.000$), and vitamin C (milligrams; Low/Mod: $p = 0.004$; Low/High: $p = 0.006$) during screen time when compared to participants in the moderate (3-5 hours/day) and high screen time categories (>5 hours/day) (Table 3). Participants in the lowest screen time category consumed less sugar ($p = 0.006$) during screen time when compared to those in the moderate screen time category. There were no statistically significant differences in the percent of dietary intake consumed during screen time between the moderate and high screen time categories.

Comparison of Dietary Intake During Television and Computer Use

When food consumption during television viewing and computer use were compared, participants consumed a significantly greater percent of energy from fat ($p=0.036$) and a greater percent of energy from saturated fat ($p=0.041$) during television viewing (Table 4).

Discussion

Previous research has shown that individuals who spend more time watching television consume greater total energy each day when compared to participants who watch less television. However, it is not clear whether the association between screen time and energy intake is a result of an increased consumption of energy dense food during television viewing as opposed to other factors (displacement of physical activity, clustering of health behaviors), or whether television and computer screen time are associated with dietary intake to a similar degree. To our knowledge, this is the first study to examine dietary intake during total screen time (television and computer use) among premenopausal women.

Several broad conclusions emerged from the study. First, there were no significant differences in total daily dietary intake (snacks/day, energy, total fat, saturated fat, sugar, fiber, calcium, and vitamin C) associated with screen time. In contrast to our findings, participants in the US Department of Agriculture's Continuing Survey of Food Intakes by Individuals (1994-1996) consumed a greater amount of total energy and macronutrients when categorized as watching more than two hours of television/day (versus less than two hours/day) (Bowman, 2006). Our results may have differed due to

differing populations and methodology. The US Department of Agriculture's Continuing Survey of Food Intakes by Individuals (1994-1996) used a nationally representative sample of adults (male and female) aged 20 years and older, collected dietary intake data through interviewer-administered 24-hour dietary-recalls on two consecutive days, and assessed screen time through one question asking how many hours they watched television or a videotape per day. Our sample was limited to premenopausal healthy women, collected dietary intake data through 7-day food records, and assessed screen time behaviors using a 7-day activity log where each participant indicated how much time was spent watching television, using the computer, playing electronic games, reading, and performing programmed physical activity each day.

Second, our findings revealed significant differences in all outcome variables for the percent of dietary intake consumed during screen time (percent of snacks, energy, total fat, saturated fat, sugar, fiber, calcium, and vitamin C) by screen time category. Specifically, participants in the lowest screen time category (<3 hours/day) consumed a significantly lower percent of their total snacks, energy, saturated fat, fiber, calcium, and vitamin C while engaged in screen time when compared to participants in the moderate (3-5 hours/day) and high (>5 hours/day) screen time categories. Further, participants in the lowest screen time category consumed a lower percent of their total daily sugar during screen time use when compared to those in the moderate screen time category. In addition to energy, fat, and sugar, we found that the proportion of healthy nutrients (fiber, calcium, and vitamin C) consumed during screen time was also highest among those in the highest screen time category. Measuring absolute dietary intake, Miller et al. found

that calcium and fiber consumption were lower among three-year-old children who watched the most television.

Matheson et al. showed that, among children, a substantial proportion of their daily total energy intake was consumed while watching television (Matheson, Killen, Wang, Varady, & Robinson, 2004). On weekdays and weekend days, ~17% and ~26% of total daily energy was consumed while watching the television. In our study, the percentage of total energy consumed during total screen time for those in low (<3 hour/day), moderate (3-5 hours/day), and high (>5 hours/day) screen time categories was ~6%, ~23%, and ~25%, respectively.

The examination of dietary intake during total screen time was chosen, as opposed to limiting the investigation to television time only, because of the dramatic increase in Internet usage (especially visiting social networking sites and watching video on the internet) in the past several years (Nielsen Media Research, 2009). The results of this study indicate that the longer participants spent engaging in screen time usage each day, the more food they consumed during such behaviors. This finding may be of increased value when considering the very low level of energy expenditure associated with television viewing, as compared with other sedentary behaviors (Ainsworth et al., 1993).

Third, when comparing dietary intake consumed during television viewing to that consumed during computer use, participants consumed foods higher in total fat and saturated fat. Increased dietary intake during television viewing has been observed among other populations. Normal weight, adult women in France were randomly assigned to

consume lunch while either watching television, listening to a recorded story, or participating in a control condition (Bellisle, Dalix, & Slama, 2004). When compared to control conditions, viewing television and listening to a recorded story were both associated with an increase in energy intake during lunch. Our study suggested similar findings in a free-living population.

In a controlled setting among college students, television viewing has been correlated to both snacking and meal frequency, as well as energy and macronutrient intake (Blass et al., 2006; Stroebele & de Castro, 2004; Thomson et al., 2008). Blass et al. reported that the amount of food and rate of consumption was increased when students watched television (Blass et al., 2006). Stroebele and de Castro reported that meal frequency was significantly increased and in between-meal intervals were decreased during days when college students ate while watching television (Stroebele & de Castro, 2004).

Lastly, when comparing the number of snacks consumed during television viewing to that consumed during computer use, we did not find significant differences. However, when the association between snack consumption and total screen time was examined, participants in the lowest screen time category (<3 hours/day) consumed a significantly lower percent of their total snacks while engaged in screen time when compared to participants in the moderate (3-5 hours/day) and high (>5 hours/day) screen time categories. Similarly, Thomson et al. found that both the number of snacks and the energy density of snacks consumed during television use was significantly lower among college students who reported viewing <1 hour/day when compared to those engaged in

moderate (1-3 hours/day) or high (≥ 4 hours/day) television use (Thomson et al., 2008).

These results may support the notion that interventions aiming to reduce screen time may also reduce dietary intake attributed to snacking.

Although absolute dietary intake did not differ by total screen time usage, it is important to note the significant differences in BMI and waist/height ratio by screen time category. These differences may relate to differences found in the proportion of dietary intake consumed during screen time. One could argue that those in the lowest screen time category consumed a lower percentage of energy, fat, and sugar (etc.) during screen time simply because they spent less time watching television and using the computer.

However, due to the observed trend in BMI and waist/height ratio by screen time category, the differences in the percent of dietary intake consumed during screen time cannot be ignored and substantiate future investigation. Further, consideration should also be given to how our findings may intersect with the lower metabolic rate that is associated with television viewing when compared to other sedentary behaviors.

The present study has several strengths that make it unique to the current body of research. To assess dietary intake during sedentary behaviors, this study used a modified 7-day weighed food record to assess food consumed during screen time (television and computer use) as opposed to food consumed at all other times. Further, there are several strengths associated with using 7-day weight food records. Detailed intake data are provided and the records do not rely on memory. Further, multiple days are more representative of usual intake and the use of food scales is thought to be more accurate than relying on household measures (Lee & Nieman, pp. 83-91, 2007). Participants also

completed a 7-day activity log that specifically assessed television and computer use, among other forms of sedentary behavior and programmed physical activity. Body composition was assessed by BIA. This measurement requires little cooperation from the participant, is safe for adults, and is a quick procedure. When compared with estimates derived from underwater weighing, estimates generated from BIA have been shown to be as good (if not slightly better) than skinfold measurements in predicting percent body fat (Lee & Nieman, pp. 209-210, 2007). Benefits to the participants of this study included obtaining information regarding their daily dietary intake and body composition analysis.

The cross-sectional design of this research study precludes making causal inferences. Although food records are considered a typical method of dietary assessment, they may increase subject burden and require literacy. Furthermore, participants may alter intake during the recording period. Food record analysis is also limited by the accuracy of the database of the Food Processor SQL (ESHA, Salem, OR). Added sugars could not be differentiated from natural sugars. Some snacks may be high in natural sugar, yet a healthy snack. When estimating body fat using BIA technology, dehydration, excessive perspiration, heavy exercise, or caffeine and alcohol use can cause an overestimation of fat mass (Lee & Nieman, pp. 209-210, 2007). Measures of dietary intake and television viewing habits were self-reported and subject to bias. We were unable to differentiate between recreational and work-related computer use. We were also unable to account for participation in other types of screen time behaviors, such as texting and watching television on smart phones. Future research should examine dietary intake during screen time in a larger sample size. Increasing the sample size is a common

method to improve the power of a statistical test. Lastly, the sample was restricted to women, therefore, generalization to men or women of other age ranges is questionable. A gender-by-screen time interaction may be significant and future research should examine such behaviors among men.

Conclusion

Eating while watching television may be a potential mechanism linking television viewing to obesity. A higher BMI and waist/height ratio were observed among participants who engaged in the greatest amount of screen time. We also found that a greater percentage of dietary intake was consumed during screen time among those in the highest screen time category. The findings of many recent studies support the call for the promotion of avoiding eating while watching television, such as the proposed recommendations outlined in the Dietary Guidelines Advisory Committee Report (USDA, 2010). Our findings and those of other studies, comport that consumption of energy dense foods, fat intake, and snacks are increased among those who watch more television, and these outcome variables are significantly higher for those who eat while watching television.

Interventions among children that have emphasized decreasing sedentary behaviors, such as television watching, have consistently resulted in improvement of weight parameters and a slowing of the increase in subjects' BMI when matched by age (DeMattia, Lemont, & Meurer, 2007). By reducing sedentary behaviors, weight gain may be prevented by impacting both sides of the weight balance equation, energy intake and energy output. Increasing physical activity can be difficult. Therefore, perhaps a small

changes approach, promoting first the avoidance of eating during sedentary behaviors, and second, the reduction in time spent in sedentary behaviors, may encourage long-term behavior change (Stroebele et al., 2009).

Future research should also examine what behaviors replace sedentary behaviors, and whether dietary intake also changes. Interventions aimed at reducing time spent in sedentary behaviors (such as watching television) should be replicated among adult populations, and further studies should continue to examine the associations between screen time and adverse dietary patterns among adults. Future recommendations limiting screen time among adults should especially be communicated to women of child-bearing age and parents so they may set a good example for their children.

Tables

Table 1. Characteristics of the Study Population as Categorized by Screen Time (Television and Computer Use)

Variable	Overall ^a (n=82)	Screen Time Category ^a			F ^{**}	P value
		<3 h/d (Low) (n=28)	3-5 h/d (Mod) (n=27)	>5 h/d (High) (n=27)		
Age (yr)	32 ± 4	31 ± 4	31 ± 5	33 ± 3	1.166	0.317
Height (cm)	167 ± 6	168 ± 6	166 ± 6	166 ± 7	1.205	0.305
Weight (kg)	77 ± 18	72 ± 16	80 ± 19	82 ± 18	2.364	0.101
Waist Circumference (cm) ^b	90 ± 14	83 ± 12 ^ψ	93 ± 15 ^φ	94 ± 12 ^φ	5.038	0.009
Waist/Height Ratio ^c	0.5 ± 0.1	0.5 ± 0.1 ^ψ	0.6 ± 0.1 ^φ	0.6 ± 0.1 ^φ	6.610	0.002
Body Mass Index (kg/m ²)	27.7 ± 5.7	25.2 ± 4.7 ^ψ	28.4 ± 5.9	29.6 ± 5.8 ^φ	4.866	0.010
Total Body Fat (%) ^d	32 ± 9	28 ± 8	32 ± 9	34 ± 8	4.050	0.021

^aAll values are mean ± standard deviation.

^bOptimal waist circumference in women ≤88 cm.

^cRatio of waist circumference to height. Optimal ratio <0.50.

^dTotal body fat (%) determined using bioelectrical impedance analysis (BIA).

^φP values for paired comparisons provided.

· Significance of post-hoc pairwise comparison with Bonferonni adjustment (P<0.017).

^{**}df=2,79 using one-way analysis of variance.

^{***}Different superscripts within the same row indicate significant differences.

Table 2. Total Dietary Intake as Categorized by Screen Time (Television and Computer Use)

Variable ^β	Overall ^a (n=82)	Screen Time Category ^a			F	P value
		<3 h/d (Low) (n=28)	3-5 h/d (Mod) (n=27)	>5 h/d (High) (n=27)		
Snacks/day	1.9 ± 0.8	2.0 ± 1.0	1.9 ± 0.8	1.9 ± 0.8	0.545	0.582
Total Energy (kcal/day)	2053 ± 475	2139 ± 437	2048 ± 529	1967 ± 457	0.905	0.409
Total Fat						
Total (g/day)	78 ± 22	81 ± 22	76 ± 21	76 ± 23	0.439	0.646
% Energy	34 ± 5	34 ± 5	33 ± 4	35 ± 5	0.486	0.617
Saturated Fat						
Total (g/day)	26 ± 9	27 ± 8	26 ± 9	25 ± 9	0.273	0.762
% Energy	11 ± 2	11 ± 2	11 ± 2	11 ± 3	0.036	0.965
Sugar						
Total (g/day)	102 ± 39	104 ± 37	108 ± 48	95 ± 30	0.796	0.455
% Energy	20 ± 6	19 ± 6	21 ± 6	20 ± 5	0.560	0.573
Fiber						
Total (g/day)	21 ± 9	22 ± 7	20 ± 7	21 ± 12	0.326	0.723
Density (g/1000 kcal)	10 ± 4	11 ± 4	10 ± 3	10 ± 4	0.270	0.764
Calcium						
Total (mg/day)	884 ± 266	943 ± 203	849 ± 282	857 ± 303	1.062	0.351
Density (mg/1000 kcal)	440 ± 125	448 ± 92	429 ± 134	442 ± 146	0.159	0.853
Vitamin C						
Total (mg/day)	87 ± 56	100 ± 71	69 ± 40	93 ± 49	2.313	0.106
Density (mg/1000 kcal)	44 ± 29	48 ± 34	35 ± 18	50 ± 31	2.235	0.114

^aAll values are mean ± standard deviation.

^βIntake variables determined using 7-day food records analyzed with Food Processor SQL, ESHA, Salem, OR.

Table 3. Percent of Dietary Intake Consumed During Total Screen Time (Television and Computer Use)

Percent of Intake Consumed During Screen Time (%) ^a	Total Screen Time Category						Chi-Square ^{**}	P [*]
	<3 h/d (Low) (n=28)		3-5 h/d (Mod) (n=27)		>5 h/d (High) (n=27)			
	Median	25 th , 75 th	Median	25 th , 75 th	Median	25 th , 75 th		
Snacks	13.4 ^ψ	1.2, 24.6	31.6	16.7, 42.9	33.3 ^φ	24.0, 53.9	15.5	0.000
Total Energy (kcal)	5.5 ^ψ	1.7, 10.2	23.2	12.8, 35.9	25.4 ^φ	15.9, 41.0	24.9	0.000
Total Fat (g)	4.4 ^ψ	1.3, 9.5	22.5	6.3, 28.1	22.0 ^φ	13.2, 40.8	26.2	0.000
Saturated Fat (g)	4.2 ^ψ	1.4, 11.7	23.8	6.6, 31.0	25.5 ^φ	15.3, 43.5	25.7	0.000
Sugar (g)	6.2 ^ψ	2.4, 15.6	25.9 ^φ	13.0, 37.4	25.1	9.5, 38.6	16.5	0.006
Fiber (g)	5.0 ^ψ	2.2, 12.4	21.2 ^φ	11.7, 43.6	26.8 ^φ	12.5, 35.2	21.2	0.000
Calcium (mg)	3.8 ^ψ	1.2, 7.6	22.8 ^φ	8.3, 29.9	25.1 ^φ	11.2, 38.4	23.2	0.000
Vitamin C (mg)	2.8 ^ψ	0.1, 9.5	18.3 ^φ	5.5, 48.0	16.0	7.9, 26.3	14.4	0.004

^aIntake variables determined using 7-day food records analyzed with Food Processor SQL, ESHA, Salem, OR. Percent of total intake that was consumed during screen time.

^{*}Significance of post-hoc pairwise comparison with Bonferonni adjustment (P<0.017).

^{**}df=2,79 using non-parametric Kruskal-Wallis Test; different superscripts within the same row indicate significant differences.

^{***}Different superscripts within the same row indicate significant differences.

Table 4. Dietary Intake Consumed During Television Viewing and Computer Use (N=82)

Dietary Intake Variable ^a	Activity During Food Consumption				Z*	P value
	Television Viewing		Computer Use			
	Median	25 th , 75 th	Median	25 th , 75 th		
Snacks	0.1	0.0, 0.4	0.1	0.0, 0.3		
Total Energy (kcal)	196	33, 360	79	0, 214		
Total Fat						
Total (g/day)	8	0, 15	2	0, 8		
% Energy	31	6, 41	24	0, 35	-2.098	0.036**
Saturated Fat						
Total (g/day)	3	0, 5	1	0, 2		
% Energy	10	1, 13	7	0, 11	-2.044	0.041**
Sugar						
Total (g/day)	7	1, 20	4	0, 13		
% Energy	15	4, 22	18	0, 28	-0.256	0.798
Fiber						
Total (g/day)	2	0, 4	1	0, 2		
Density (g/1000 kcal)	7	4, 14	8	0, 13	-0.380	0.704
Calcium						
Total (mg/day)	55	7, 159	15	0, 77		
Density (mg/1000 kcal)	329	95, 485	192	0, 471	-1.112	0.266
Vitamin C						
Total (mg/day)	2	0, 9	0	0, 6		
Density (mg/1000 kcal)	12	0, 37	3	0, 30	-0.746	0.456

^aIntake variables determined using 7-day food records analyzed with Food Processor SQL, ESHA, Salem, OR. Absolute amount, percent energy, and nutrient density consumed during respective activity.

*df=2,79 using non-parametric Wilcoxon Signed Rank Test.

· Test is significant at the 0.05 level (2-tailed).

References

- Ainsworth, B. E., Haskell, W. L., Leon, A. S., Jacobs, D. R., Jr, Montoye, H. J., Sallis, J. F., & Paffenbarger, R. S., Jr. (1993). Compendium of physical activities: Classification of energy costs of human physical activities. *Medicine and Science in Sports and Exercise*, 25(1), 71-80.
- American Academy of Pediatrics. (2001). Committee on Public Education. American Academy of Pediatrics: Children, adolescents, and television. *Pediatrics*, 107(2), 423-426.
- Ashwell, M. (2009). Obesity risk: importance of the waist-to-height ratio. *Nursing Standard*, 23(41), 49-54. Retrieved April 1, 2010, from Nursing Standard Official Website: <http://nursingstandard.rcnpublishing.co.uk/>
- Bellisle, F., Dalix, A. M., & Slama, G. (2004). Non food-related environmental stimuli induce increased meal intake in healthy women: Comparison of television viewing versus listening to a recorded story in laboratory settings. *Appetite*, 43(2), 175-180. doi:10.1016/j.appet.2004.04.004
- Bennett, G. G., Wolin, K. Y., Viswanath, K., Askew, S., Puleo, E., & Emmons, K. M. (2006). Television viewing and pedometer-determined physical activity among multiethnic residents of low-income housing. *American Journal of Public Health*, 96(9), 1681-1685. doi:10.2105/AJPH.2005.080580
- Blass, E. M., Anderson, D. R., Kirkorian, H. L., Pempek, T. A., Price, I., & Koleini, M. F. (2006). On the road to obesity: Television viewing increases intake of high-density foods. *Physiology & Behavior*, 88(4-5), 597-604. doi:10.1016/j.physbeh.2006.05.035
- Borzekowski, D. L., & Robinson, T. N. (2001). The 30-second effect: An experiment revealing the impact of television commercials on food preferences of preschoolers. *Journal of the American Dietetic Association*, 101(1), 42-46. doi:10.1016/S0002-8223(01)00012-8
- Bowman, S. A. (2006). Television-viewing characteristics of adults: Correlations to eating practices and overweight and health status. *Preventing Chronic Disease*, 3(2), A38.
- Center for Disease Control and Prevention. (2009). Recommended community strategies and measurements to prevent obesity in the United States. *MMWR*, 58(No. RR-7).

- Chamberlain, L. J., Wang, Y., & Robinson, T. N. (2006). Does children's screen time predict requests for advertised products? Cross-sectional and prospective analyses. *Archives of Pediatrics & Adolescent Medicine*, *160*(4), 363-368. doi:10.1001/archpedi.160.4.363
- Coon, K. A., Goldberg, J., Rogers, B. L., & Tucker, K. L. (2001). Relationships between use of television during meals and children's food consumption patterns. *Pediatrics*, *107*(1), E7.
- Cox, B.D., & Whichelow, M. (1996). Ratio of waist circumference to height is better predictor of death than body mass index. *British Medical Journal*, *313*(7070), 1487. Retrieved April 13, 2010, from British Medical Journal Official Website: <http://www.bmj.com>
- DeMattia, L., Lemont, L., & Meurer, L. (2007). Do interventions to limit sedentary behaviours change behaviour and reduce childhood obesity? A critical review of the literature. *Obesity*, *8*(1), 69-81. doi:10.1111/j.1467-789X.2006.00259.x
- Egger, G., & Swinburn, B. (1997). An "ecological" approach to the obesity pandemic. *BMJ (Clinical Research Ed.)*, *315*(7106), 477-480.
- Fulton, J. E., Wang, X., Yore, M. M., Carlson, S. A., Galuska, D. A., & Caspersen, C. J. (2009). Television viewing, computer use, and BMI among US children and adolescents. *Journal of Physical Activity & Health*, *6* Suppl 1, S28-35.
- Gore, S. A., Foster, J. A., DiLillo, V. G., Kirk, K., & Smith West, D. (2003). Television viewing and snacking. *Eating Behaviors*, *4*(4), 399-405. doi:10.1016/S1471-0153(03)00053-9
- Healy, G. N., Dunstan, D. W., Salmon, J., Shaw, J. E., Zimmet, P. Z., & Owen, N. (2008). Television time and continuous metabolic risk in physically active adults. *Medicine and Science in Sports and Exercise*, *40*(4), 639-645. doi:10.1249/MSS.0b013e3181607421
- Hetherington, M. M. (2007). Cues to overeat: Psychological factors influencing overconsumption. *The Proceedings of the Nutrition Society*, *66*(1), 113-123. doi:10.1017/S0029665107005344
- Hu, F. B., Li, T. Y., Colditz, G. A., Willett, W. C., & Manson, J. E. (2003). Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA : The Journal of the American Medical Association*, *289*(14), 1785-1791. doi:10.1001/jama.289.14.1785

- James, W.P.T. (1992). Epidemiology of obesity. *International Journal of Obesity*, 16(Suppl):S23-26.
- Johnson, K. M., Nelson, K. M., & Bradley, K. A. (2006). Television viewing practices and obesity among women veterans. *Journal of General Internal Medicine*, 21 Suppl 3, S76-81. doi:10.1111/j.1525-1497.2006.00379.x
- Kronenberg, F., Pereira, M. A., Schmitz, M. K., Arnett, D. K., Evenson, K. R., Crapo, R. O., Jensen, R. L., Burke, G. L., Sholinsky, P., Ellison, R. C., & Hunt, S. C. (2000). Influence of leisure time physical activity and television watching on atherosclerosis risk factors in the NHLBI family heart study. *Atherosclerosis*, 153(2), 433-443.
- Lee, R.D., & Nieman, D.C. (2007). Measuring Diet. In *Nutritional Assessment* (4th Ed). pp. 83-91. New York: McGraw-Hill.
- Lee, R.D., & Nieman, D.C. (2007). Anthropometry. In *Nutritional Assessment* (4th Ed). pp. 209-210.
- Lu, M., Ye, W., Adami, H.O., & Weiderpass, E. (2006). Prospective study of body size and risk for stroke amongst women below age 60. *Journal of Internal Medicine*, 260(5), 442-450. doi:10.1111
- Matheson, D. M., Killen, J. D., Wang, Y., Varady, A., & Robinson, T. N. (2004). Children's food consumption during television viewing. *The American Journal of Clinical Nutrition*, 79(6), 1088-1094.
- McCarthy, S. N., Gibney, M. J., Flynn, A., & Irish Universities Nutrition Alliance. (2002). Overweight, obesity and physical activity levels in irish adults: Evidence from the North/South ireland food consumption survey. *The Proceedings of the Nutrition Society*, 61(1), 3-7.
- Miller, S. A., Taveras, E. M., Rifas-Shiman, S. L., & Gillman, M. W. (2008). Association between television viewing and poor diet quality in young children. *International Journal of Pediatric Obesity*, 1-9. doi:10.1080/17477160801915935
- Nielsen Media Research. (2007). Nielsen reports television tuning remains at record levels, digital video recorders grow in popularity. New York: Nielsen Media Research, AC Nielsen.
- Nielsen Media Research. (2009). A2/M2 Three Screen Report, Vol 4-6. New York: Nielsen Media Research, AC Nielsen.

- Ogden, C. L., Carroll, M. D., Curtin, L. R., McDowell, M. A., Tabak, C. J., & Flegal, K. M. (2006). Prevalence of overweight and obesity in the United States, 1999-2004. *JAMA : The Journal of the American Medical Association*, 295(13), 1549-1555. doi:10.1001/jama.295.13.1549
- Ogden, C. L., Carroll, M. D., McDowell, M. A., & Flegal, K. M. (2007). Obesity among adults in the United States--no statistically significant change since 2003-2004. *NCHS Data Brief*, (1)(1), 1-8.
- Pettee, K. K., Ham, S. A., Macera, C. A., & Ainsworth, B. E. (2009). The reliability of a survey question on television viewing and associations with health risk factors in US adults. *Obesity (Silver Spring, Md.)*, 17(3), 487-493. doi:10.1038/oby.2008.554
- Stamatakis, E., Hirani, V., & Rennie, K. (2009). Moderate-to-vigorous physical activity and sedentary behaviours in relation to body mass index-defined and waist circumference-defined obesity. *The British Journal of Nutrition*, 101(5), 765-773. doi:10.1017/S0007114508035939
- Stroebele, N., & de Castro, J. M. (2004). Television viewing is associated with an increase in meal frequency in humans. *Appetite*, 42(1), 111-113. doi:10.1016/j.appet.2003.09.001
- Stroebele, N., de Castro, J. M., Stuht, J., Catenacci, V., Wyatt, H. R., & Hill, J. O. (2009). A small-changes approach reduces energy intake in free-living humans. *Journal of the American College of Nutrition*, 28(1), 63-68.
- Thomson, M., Spence, J. C., Raine, K., & Laing, L. (2008). The association of television viewing with snacking behavior and body weight of young adults. *AJHP: American Journal of Health Promotion*, 22(5), 329-335.
- US Department of Agriculture. (2010). Dietary Guidelines for Americans. Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2010. Retrieved June 15th, 2010, from the US Department of Agriculture Official Website: <http://www.cnpp.usda.gov/DGAs2010-DGACReport.htm>.
- US Department of Health and Human Services. (1996). Physical activity and health: a report of the Surgeon General. Atlanta, Georgia: US Department of Health and Human Services, CDC.
- US Department of Health and Human Services. (2009). Developing Healthy People 2020. Physical activity and fitness. Retrieved December 30th, 2009, from the USDHHS Official Website:

<http://www.healthypeople.gov/HP2020/Objectives/ViewObjective.aspx?Id=106&TopicArea=Physical+Activity+and+Fitness&Objective=PAF+HP2020%E2%80%938&TopicAreaId=39>

Young, B. (2003). Does food advertising influence children's food choices? *International Journal of Advertising*, 22, 441-459.

Chapter 5

Effects Of A Healthy Shopping Intervention and Annual Household Income On Shopping Basket Nutrient Content: A Randomized Controlled Trial

Abstract

An ecological approach is the recommended strategy for population behavior change because it suggests that personal, social, and environmental factors all influence behavior outcomes. The supermarket is an environment in which all three influential factors are encompassed. Supermarket settings also offer an important environment for improving eating patterns because of the access to large groups of people. Hence, a randomized controlled trial was conducted at a supermarket to pilot test a brief face-to-face healthy shopping intervention to determine whether food purchases of participants who received the intervention differed from those in the control group. The secondary objective of this study was to determine whether the effects of the intervention varied according to annual household income. One hundred and fifty-three adult shoppers were recruited on-site and randomly assigned to either the control group or the intervention group. Those in the intervention group received a 10-minute education session that introduced the shopper to a healthy shopping program focusing on how to purchase foods with less saturated and trans fat, as well as including more fruits and vegetables. The primary outcome variables were calculated for the entire shopping basket of each participant and included total mean energy density, total fat, saturated fat, trans fat, and servings of fruits, vegetables, and dark green and deep yellow vegetables. These variables were derived through nutritional analysis of shopping baskets via digital photographs and duplicate receipts of purchased

foods. We found a significant main effect for the intervention group on servings of fruit ($p=0.002$) as those who received the intervention purchased more fruit. Participants in the high-income group purchased more servings of vegetables when compared to both the lower income ($p=0.003$) and middle-income ($p=0.007$) groups. There were also significant main effects for both income ($p=0.002$) and intervention group ($p=0.039$) on purchases of dark green/deep yellow vegetables. High-income participants purchased significantly more servings of dark green/deep yellow vegetables when compared to lower income participants ($p=0.005$); those who received the intervention purchased significantly more servings than those in the control group. Among participants who received the intervention, low-income participants purchased foods of lower energy density ($p=0.039$) and middle-income participants purchased more fat (Low/Middle $p=0.026$; Middle/High $p=0.016$). Long-term evaluations of supermarket interventions should be conducted to improve the evidence base and to determine the potential for impact on improving health.

Introduction

More than 60% of all deaths worldwide have been attributed to chronic disease [World Health Organization (WHO), 2005]. Hypertension, hypercholesterolemia, inadequate intake of fruits, vegetables, overweight and obesity, physical inactivity, and tobacco use account for the majority of risk for chronic disease (WHO, 2005). The first five of these risk factors can be associated with dietary intake (Bull, F.C., Armstrong, T.P., Dixon, T., Ham, S., Neiman, A., & Pratt, M., 2004). Reducing the intake of foods high in saturated fat, trans fat, and sugar are the focus of many dietary research interventions, policy initiatives, and media campaigns. Several studies also suggest that a healthful dietary pattern, one that includes fruit and vegetables, high fiber, and reduced-fat dairy, can protect against weight gain and chronic disease (McCullough et al., 2002; Newby, Muller, Hallfrisch, Andres, & Tucker, 2004).

In 2007-2008, the prevalence of obesity among adult men and women residing in the US was approximately 32.2% and 35.5%, respectively (Flegal, Carroll, Ogden, & Curtin, 2010). Although the increases in obesity prevalence during the past decade do not appear to be continuing at the same rate, obesity remains a significant public health problem (Ogden, Carroll, McDowell, & Flegal, 2007). The rise in obesity prevalence in recent decades has focused interest on the environment as a possible causal mechanism. Hence, policy and environmental interventions at the population level have recently been the focus of health promotion strategies (Ammerman, Lindquist, Lohr, & Hersey, 2002).

Because personal, social, and environmental factors influence behavior outcomes, researchers recommend an ecological approach when investigating the influences of

obesity (Sallis & Owen, 2002). The supermarket encompasses all three modalities of influence, specifically on dietary intake. Supermarkets play an important role in food purchasing and dietary intake as the average person makes two trips to the supermarket per week and spends approximately \$28 per week on grocery expenses (Food Marketing Institute, 2001; Food Marketing Institute, 2007). Further, the percent of income spent on food-at-home is 5.7%. Not only influencing the foods people consume at home, supermarkets now account for nearly one-fifth of all take-out foods. The average person spends approximately 4% of disposable income on supermarket food away-from-home, perhaps replacing restaurant and fast-food meals (Food Marketing Institute, 2007). Therefore, supermarket settings offer an important potential for improving eating patterns because of the access to individuals and groups of people.

Supermarket interventions

The *2005 Dietary Guidelines for Americans* recommend that consumers replace some foods in their diet with more nutrient-dense options, as opposed to the increasingly consumed energy-dense foods (USDA, 2005). Currently, no guideline helps consumers make these important decisions. To follow other dietary recommendations, such as limiting “discretionary calories,” consumers need an easier way to compare different food items. Interventions in the supermarket setting aim to make it easier for individuals to make healthy food choices. The supermarket interventions tested in the 1980’s and 1990’s often included strategies such as coupons and price reduction; availability, variety, and convenience for fruit and vegetable purchases; promotion and advertising; and point-of-purchase (POP) information (Ernst et al., 1986; Hunt et al., 1990; Kristal,

Goldenhar, Muldoon, & Morton, 1997; Paine-Andrews, Francisco, Fawcett, Johnston, & Coen, 1996; Rodgers et al., 1994). However, these interventions reported mixed effectiveness, included poor outcome measures, and limited outcome analysis to specific, targeted items. Positive associations have been reported between the amount of health-education material provided by supermarkets and the healthful quality of individual diets (Cheadle et al., 1991). Although these associations did not reach statistical significance, these findings are promising and encourage further investigation into this type of environmental modality for improving healthful food purchasing.

Point-of-Purchase strategies

Supermarket interventions that use POP methodology, shelf labels, signage, and food demonstrations to specify healthy food choices are usually based on established criteria such as the Dietary Guidelines for Americans (Glanz & Yaroch, 2004). The basic POP methodology is often combined with a color-coded system, posters, brochures, and fliers, and may or may not be brand-specific. POP supermarket interventions have the potential to reach large numbers of people at a low cost (Kristal et al., 1997). Research has shown that POP strategies can influence behavior (Matson-Koffman, Brownstein, Neiner, & Greaney, 2005). Researchers have also found that POP programs are feasible in low-income areas (Lang, Mercer, Tran, & Mosca, 2000; O'Loughlin, Ledoux, Barnett, & Paradis, 1996). Further, consumer decision-making studies suggest that the average shopper arrives at the store undecided about what he/she will buy and is easily distracted by displays and packaging (Innman J, Winer RS. 1998). Consumers are also more likely to make unplanned, in-store purchases during major (versus fill-in) trips to the

supermarket and when not shopping with a list. However, consumers are equally likely to make unplanned purchases regardless of whether they are shopping with a list (Innman & Winer, 1998). These findings may suggest that intervention at the POP may influence decision-making of both types of shoppers.

Several trials have been conducted to test the effectiveness of supermarket interventions aimed at improving the nutrition of food purchases. One of the most recent trials implemented a 2 x 2 factorial design to evaluate the effect of price discounts and tailored nutrition education on supermarket purchases (Ni Mhurchu, Blakely, Jiang, Eyles, & Rodgers, 2010). The following intervention groups were compared: price discounts, tailored nutrition education, price discounts plus nutrition education, and a control group. Food purchase data were gathered using electronic scanner sales data. The primary outcome variable was change from baseline in percentage energy from saturated fat purchased; and secondary outcomes were change in other nutrients and change in the quantity of healthier foods purchased by weight. At the end of 6 months, there was no change in percentage of energy from saturated fat, or other nutrient purchases regardless of intervention type. However, participants randomized to the price discount group bought significantly “healthier” foods at 6 months and 12 months. Although researchers concluded that education had no effect on food purchases, there was no evidence of whether participants actually received and read the education materials. The education intervention in this study consisted of printed packages of food-group-specific nutrition information by mail.

Another recent study evaluated the effect of a supermarket POP program called Guiding Stars (Sutherland, Kaley, & Fischer, 2010). Guiding Stars is currently implemented in stores located in the Northeastern United States and is driven by an algorithm that calculates weighted scores based on points subtracted for *trans* fat, saturated fat, cholesterol, sodium, and added sugar, and credited for vitamins, minerals, fiber, and whole grains. To test whether shoppers were using the program, food purchasing data were examined preimplementation (of Guiding Stars), and 1 and 2 years later. Although individual purchasing data were not collected, Sutherland et al. (2010) compared the volume of foods purchased with star ratings and those without. At one- and two-years following the implementation of the Guiding Stars program, consumers purchased significantly more items with a star rating. This should translate to healthier food purchases. When the researchers examined ready-to-eat cereal purchases specifically, consumers purchased significantly more ready-to-eat cereals with stars (less added sugars, more fiber) and fewer without star rating (high-sugar, low-fiber) at the one-year follow-up. In other words, consumers were purchasing ready-to-eat cereal with less added sugar and more fiber.

In addition to environmental strategies to increase availability of healthy foods, the Healthy Foods Hawaii intervention used a POP strategy aimed to promote healthier food choices and food preparation methods (Gittelsohn et al., 2010). Posters, educational displays, and shelf labels were included in the POP segment of the study. The authors found that among the stores implementing the intervention, sales of several of the

promoted foods increased. Interestingly, few participants reported seeing the POP signage.

In a review of nutrition environmental interventions at the POP, Seymour et al. examined 10 studies that were based in supermarkets and found mixed results. Half of the studies showed no change in targeted food items (ie. low-fat foods), and half of the studies showed an increase in one-half of the targeted food items (Seymour, Yaroch, Serdula, Blanck, & Khan, 2004). Hence, researchers have suggested that additional research is necessary to determine the impact of POP nutrition interventions in supermarkets. Further, future research should build on current research by repeating studies that show promise, as well as implementing more powerful POP interventions.

Socioeconomic position

The influence of socioeconomic position (SEP) on dietary intake has been the topic of many studies in the past decade. Research has shown that individuals with a lower educational attainment or income are less likely to follow the Dietary Guidelines recommended by the United States Department of Agriculture (USDA) when compared with those of higher educational attainment or income (Galobardes, Morabia, & Bernstein, 2001; Giskes, Turrell, van Lenthe, Brug, & Mackenbach, 2006; Mullie, Clarys, Hulens, & Vansant, 2010; Roos, Prattala, Lahelma, Kleemola, & Pietinen, 1996). Mullie et al. (2010) observed that higher educational attainment and income were associated with the healthiest dietary patterns. Similarly, Monsivais and Drewnowski (2009) reported that those who consumed diets of lower energy density, also consumed more nutrients and spent more money. They also observed that among individuals who

consumed higher energy-dense diets, lower intakes of micronutrients and fiber were reported, as well as lower food costs.

Giskes et al. (2006) reported significant associations between individual-level SEP and food choice, breakfast consumption, and fruit intake. These researchers also reported that an individual's socioeconomic characteristics may impact dietary intake more than the socioeconomic characteristics of the area in which they live. Giskes, Van Lenthe, Brug, Mackenbach, & Turrell (2007) not only reported that individuals of a lower SEP were less likely to make food purchases consistent with the dietary guideline recommendations, but also that perceived availability and price differences were associated with the purchase of recommended foods. Particularly, perceived availability made a consistently small contribution to explaining inequalities in food purchasing. These findings suggest that supermarket POP interventions may impact purchases of individuals of lower SEP because these interventions typically include signage to increase awareness of healthy foods and education components.

Study objectives

The purpose of this study was to pilot test a brief face-to-face healthy shopping intervention to determine whether food purchases of participants who received the treatment differed from those in the control group. The null hypothesis for the primary objective was that there would be no differences in the nutrient profile (energy density, total fat, saturated fat, trans fat, and servings of fruits and vegetables) of food purchases by intervention group. The secondary objective of this study was to determine whether

the effects of the healthy shopping intervention vary according to annual household income.

Participants and methods

Study design

A randomized controlled trial was conducted at a supermarket store in Surprise, Arizona, between August and November 2009. The study was designed to test the effects of a brief face-to-face healthy shopping intervention promoting a point-of-purchase (POP) *EatSmart* program on fat, fruit, and vegetable purchases. The study protocol and related documents were approved by the Arizona State University Institutional Review Board and the University of Arizona Human Subjects Protection Program Office.

The supermarket in the trial was a member of a local retail chain that recently implemented a POP healthy shopping program, *EatSmart*, consisting of signage and education materials designed to make shopping for healthy foods easy. This supermarket chain has over 150 stores in Arizona with over 1.6 million shoppers annually. Supermarket management determined the specific store location where the study took place.

EatSmart includes colorful nutrition shelf tags identifying whether a food is a “healthier option,” is “heart healthy,” has “low sodium,” is “calcium rich,” or is an “immune booster.” The shelf tags are placed below the targeted items. Approximately 600 shelf tags (total for all five labels) are placed in each store. The program also includes a free newsletter featuring nutritional foods and recipes, free nutritional cards (bookmarks) with healthy eating tips and shopping lists, and a year-long designated *EatSmart* end cap

display in stores featuring healthy products. The face-to-face intervention briefly introduced the six *EatSmart* nutrition shelf tags, but focused on Heart Healthy (shopping for non-fat and low-fat dairy products, leaner beef and pork, vegetable oil, and other sources of healthy fats); and Immune Booster (increasing fruit and vegetable purchasing, especially dark green, orange, red, and yellow colors).

Participants, recruitment, and randomization

One hundred and fifty-three adult shoppers were recruited on-site. Data collection occurred on weekdays and weekends for six continuous hours each day, over the course of four months. Recruitment occurred at a table located near the store entrance. Shoppers who approached the researchers received a study description and were offered a \$15 gift card as a participation incentive. Study inclusion criteria were as follows: age >18 y, the primary household shopper, planning to purchase at least 15 different food items, able to speak and write in English, able to shop unassisted, have transportation, and own a home refrigerator. Eligible participants were randomly assigned to either the intervention or control group by a randomization table.

Study protocol

Interested shoppers who met inclusion criteria read and signed the informed consent. Those assigned to the control group were instructed to return to the research table after performing their usual shopping. Upon return, participants in the control group completed two surveys: a demographic survey and a survey that asked the participants to indicate the store signage they observed while shopping. Digital photographs of the foods in the shopping baskets were taken by researchers. Prior to exiting the supermarket, a

duplicate receipt was collected and the participant was given a \$15 gift card. Participants in the control group were then offered the same face-to-face healthy shopping session received by the intervention group.

Shoppers randomized to the intervention group received a 10-minute face-to-face education session prior to shopping. This session introduced the shopper to the *EatSmart* POP healthy shopping program focusing on how to purchase foods with less saturated and trans fat, as well as including more fruits and vegetables. The purpose of the face-to-face session was to help shoppers identify healthier food options using the POP *EatSmart* program implemented in the store. After participants in the treatment group received the intervention, they were instructed to return to the research table after shopping. Upon return, participants randomized to the treatment group also filled out the same two surveys while a research assistant photographed the contents of the shopping basket. Prior to exiting the supermarket, participants submitted their duplicate shopping receipts and received a \$15 gift card.

Dependent variables

The primary outcome variables were calculated for the entire shopping basket of each participant and included total mean energy density (kcal/100 g); total fat, saturated fat, and trans fat (g/1000 kcal and percent energy); and servings of fruits/1000 kcal, vegetables/1000 kcal, and dark green and deep yellow vegetables/1000 kcal. These variables were derived through nutritional analysis of participant shopping baskets via digital photographs and duplicate receipts of purchased foods. Nutritional analysis of

food purchases was performed using the Nutrition Data System for Research (NDSR; Nutrition Coordinating Center, Minneapolis, MN).

NDSR estimates servings of fruits and vegetables according to the USDA standards. Servings of fruits/1000 kcal, vegetables/1000 kcal, and dark green and deep yellow vegetables/1000 kcal were calculated based upon the original serving count subgroups from the NDSR output. NDSR fruit and vegetable serving count subgroups are mutually exclusive. To determine servings of fruits, a sum of the following three NDSR subgroups was calculated: citrus fruit, fruit excluding citrus fruit, avocado and similar. Total servings of vegetables were determined by taking a sum of the following eight NDSR subgroups: dark green vegetables, deep yellow vegetables, tomato, white potatoes, fried potatoes, other starchy vegetables, legumes, and other vegetables. Servings of dark green and deep yellow vegetables were grouped together as the last dependent variable. Although the weights of the fruits and vegetables on the cash register receipt included portions that would be considered waste at the time of consumption, the servings determined by NDSR included edible portions only.

Independent variables

Independent variables included participant height (self-reported), weight (self-reported), body mass index, age, gender, race/ethnicity, household income range, highest educational attainment, and number of children and adults in the household. Participants were also asked to indicate the number of occasions per week they made convenience store purchases, prepared their own meals, visited fast food or take-out restaurants, dined in restaurants, and consumed fruits and vegetables. Fruit, fruit juice, and vegetable intake

questions in the survey were modified from Module 16 of the Behavioral Risk Factor Surveillance System Survey Questionnaire (BRFSS; CDC, 2007)

Household income range and number of members in household were used to determine percent of the poverty guideline for each participant. The federal poverty guidelines were assigned as determined by the US Department of Health and Human Services and the Assistant Secretary for Planning and Evaluation (DHHS & ASPE, 2010). For each participant, an income estimate was determined by taking the mid-point of the income range from the survey. The number of people in each household was compared against the poverty guideline for 2007 and the standard income level for the specified number of household members was determined. The percent of the poverty guideline was calculated for each participant by dividing the midpoint of the income range by the federal poverty guideline (dependent on household number) and multiplying by 100. Participants were divided into three groups according to the percent of the federal poverty guideline: $\leq 244\%$, 245-385%, $\geq 386\%$. These income groups were determined based on the sample distribution and those that are used in the literature. For example, 250% of the federal poverty guideline represents an annual income of \$55,135.00 for a family of four.

Sample size and statistical analysis

The sample size was based on the difference between the control and treatment groups in terms of servings of fruits and vegetables as the primary endpoint. Sample size was determined through G*Power and PASS 2008 (Number Cruncher Statistical Systems, Kaysville, UT; www.ncss.com). A sample of 128 participants (64 per arm) was

estimated to provide >80% power at a 5% level of significance (2-sided) to detect a medium effect ($d=.50$) (Cohen, 1988). The estimated sample size was inflated to account for a possible 10% attrition rate (70 per group).

Statistical analyses were performed using SPSS (version 17.0, 2008, SPSS Institute Inc, Chicago, IL). Kolmogorov-Smirnov tests and histograms were generated to determine whether the dependent variables displayed normal distribution. The Kolmogorov-Smirnov tests of normality were violated for all variables; therefore, medians and interquartile range are displayed. Chi-square and Mann-Whitney U test examined key independent variables, such as BMI and age, between the treatment and control.

Mann-Whitney U tests compared the dependent variables [energy density (kcal/100 g), total fat (g/1000 kcal and percent energy of basket), saturated fat (g/1000 kcal and percent energy of basket), trans fat (g/1000 kcal and percent energy of basket), fruits (servings/1000 kcal), total vegetables (servings/1000 kcal), and dark green and deep yellow vegetables (servings/1000 kcal) by intervention group; α was set at 0.05.

Participants were divided into three groups according to their income, as determined by percent of the federal poverty guideline ($\leq 244\%$, 245-385%, $\geq 386\%$). A two-way between-groups analysis of variance (ANOVA) was conducted to explore the impact of intervention group and income (percent federal poverty guideline) on nutrient profile of foods purchased [energy density (kcal/100 g), total fat (g/1000 kcal and percent energy of basket), saturated fat (g/1000 kcal and percent energy of basket), trans fat (g/1000 kcal and percent energy of basket), fruits (servings/1000 kcal), total vegetables

(servings/1000 kcal), and dark green and deep yellow vegetables (servings/1000 kcal)]. Post hoc comparisons using the Bonferroni test were used for multiple comparisons. Parametric tests were utilized because Mann-Whitney U tests and Independent T-tests yielded the same significance for all outcome variables.

Results

Recruitment and participant characteristics

Of approximately 300 individuals who inquired about the study, 153 met inclusion criteria and were randomly assigned to either the treatment (n=70) or the control (n=83) group. Sixty-five percent of the intervention group and 29% of the control group reported seeing *EatSmart* shelf tags. We can conclude that there was only modest contamination of the control group from *EatSmart* shelf tags being posted throughout the store. This contamination, however, would reduce our ability to find an effect. With the exception of percent of the federal poverty guideline, descriptive characteristics were not significantly different between groups (Table 1). Eighty-one percent of the entire study population was female (mean age 41 y), and 78% was of white race/ethnicity. Sixty-one percent had less than a college degree, and 39% had an annual household income of less than \$60,000. The control group [median (Md)=355%] reported a greater percent of the federal poverty guideline when compared to those in the intervention group (Md=295%) (p=0.044).

Total, saturated, and trans fat

A Mann-Whitney U test showed no significant difference in energy density (per 100 g) of the shopping baskets when comparing the intervention and control groups,

U=2611, $z=-1.07$, $p=0.282$, $\eta^2=0.1$ (Table 2). Similarly, there was no difference in purchased total fat (Md=39 g/1000 kcal and 35% energy for both groups), U=2855, $z=-0.18$, $p=0.855$, $\eta^2=0$; saturated fat (Md=14 g/1000 kcal and 12% energy for both groups), U=2662, $z=-0.89$, $p=0.374$, $\eta^2=0.1$; and trans fat (Md=1.5 g/1000 kcal and 1% energy for both groups), U=2813, $z=-0.34$, $p=0.736$, $\eta^2=0$, when comparing the intervention and control groups.

Fruits and vegetables

Table 2 also shows that there were no significant differences in purchased fruit juice (Md=0 servings/1000 kcal for both groups), U=2536, $z=-1.58$, $p=0.114$, $\eta^2=0.1$; total vegetables (intervention Md=1.3 servings/1000 kcal, control Md=1.0 servings/1000 kcal), U=2494, $z=-1.51$, $p=0.132$, $\eta^2=0.1$; and dark green/deep yellow vegetables (intervention Md=0.2 servings/1000 kcal, control Md=0.1 servings/1000 kcal), U=2545, $z=-1.35$, $p=0.177$, $\eta^2=0.1$. However, the intervention group purchased significantly more servings of fruit (Md=0.7 servings/1000 kcal) when compared to the control group (Md=0.4 servings/1000 kcal), U=2079, $z=-3.03$, $p=0.002$, $\eta^2=0.3$.

Socioeconomic status

Table 3 shows the descriptive statistics of food purchase by income level (percent of the federal poverty line) and intervention group. A two-way between-groups ANOVA was conducted to explore the impact of intervention group and income (percent federal poverty guideline) on the nutrient profile of foods purchased (Table 4). An omnibus ANOVA showed that the interaction effect between the intervention group and income

was statistically significant for both energy density (kcal/100 g), $F(2,135)=4.02$, $p=0.020$; and total fat (g/1000 kcal), $F(2,135)=3.06$, $p=0.050$. Among participants who received the intervention, those in the lower income group had lower energy density purchases when compared to those in the middle-income group ($p=0.039$). Among those with lower income and who received the intervention, food purchases were lower in energy density when compared to lower income individuals in the control group ($p=0.015$). Among those who received the intervention, participants in the middle-income group purchased more fat (g/1000 kcal) when compared to both lower income ($p=0.026$) and high-income ($p=0.016$) participants. For saturated fat purchases (g/1000 kcal), there was a statistically significant main effect for income, $F(2,135)=3.18$, $p=0.045$, however, the Bonferroni post hoc comparison did not reach statistical significance. No significant differences in the nutrient composition of food purchases were found by education level.

The two-way ANOVA also reported a significant main effect for intervention group on servings of fruit (per 1000 kcal), $F(2,135)=9.93$, $p=0.002$; as those who received the intervention purchased more fruit. There was also a significant main effect for income group on servings of vegetables (per 1000 kcal), $F(2,135)=7.75$, $p=0.001$. Participants in the high-income group purchased more servings of vegetables when compared to both the lower income ($p=0.003$) and middle-income ($p=0.007$) groups. Lastly, there were significant main effects for both income, $F(2,135)=2.79$, $p=0.002$; and intervention group, $F(2,135)=4.33$, $p=0.039$, on purchases of dark green/deep yellow vegetables. Participants in the high-income group purchased significantly more servings of dark green/deep yellow vegetables when compared to lower income participants

($p=0.005$); and participants who received the intervention purchased significantly more servings than those in the control group.

Discussion

In this randomized trial, we used Mann-Whitney U tests to evaluate our primary hypothesis. We found that the intervention did not have a significant effect on energy density (kcal/100 g), fat density (total, saturated, and trans), fruit juice, or vegetable servings of food purchases when compared to that of the control group. However, the intervention group did purchase more servings of fruit when compared to the control group (Md=0.7 and 0.4 servings/1000 kcal respectively).

Mhurchu et al. (2010) reported that neither price discounts nor nutrition education had a significant impact on energy density, total fat, saturated fat, or vegetable purchases. However, the results of our study indicated significantly more servings of fruits were purchased by those randomized to the intervention group when compared to the control group. Kristal et al. (1997) evaluated a supermarket intervention to increase the consumption of fruits and vegetables. Advertisements, coupons, recipe flyers, store signage, and food demonstrations were utilized in their supermarket intervention but failed to increase fruit and vegetable consumption as measured by a food frequency questionnaire at baseline and one year post randomization.

Gittelsohn et al. (2010) did not observe a significant impact on Healthy Eating Index component scores (including fat, saturated fat, fruits, and vegetables) among adult caregivers in Hawaii following the Healthy Foods Hawaii intervention. Similar to our study, this intervention utilized POP strategies, such as posters, educational displays, and

shelf labels), to improve healthy food purchases. Dietary intake variables included diet quality components (Healthy Eating Index scores), and were determined via participant dietary recalls. In contrast to our findings, Gittelsohn et al. (2010) did not observe an increase in fruit intake. Differences in outcome measures could account for the difference in findings (density or servings in shopping basket vs Healthy Eating Index score).

Cheadle et al. (1991) suggested that an underlying determinant of individual dietary practice and store behavior is the socioeconomic position of community residents. In their study, higher education levels of community residents were associated with greater availability of healthy foods, more health-education items in the store, and more healthful diets reported by respondents. While our study did not find differences in the nutrient composition of food purchases by education level, there were differences noted by income level.

Regardless of intervention group, participants in the high-income group purchased more servings (per 1000 kcal) of total vegetables and dark green and deep yellow vegetables. Others have also reported healthier dietary patterns among individuals with higher income (Giskes et al., 2006; Giskes et al., 2007; Mullie et al., 2010). Mullie et al. (2010) reported that healthier dietary patterns were found among those with a higher income. Similarly, Giskes et al. (2007) reported that low-income individuals were less likely to make food purchases consistent with the dietary guidelines. Our study found no differences by income level for fruit intake. In contrast to our findings, Giskes et al. (2005) reported that individual-level SEP was associated with fruit intake.

Among participants who received the intervention, low-income participants purchased foods of lower energy density (kcal/100 g), and middle-income participants purchased more fat (g/1000 kcal). In contrast to our findings, Mullie et al. (2010) found a negative association between energy density and nutrient density of dietary patterns, and healthy dietary patterns were associated with a higher income.

The strengths of this pilot study include the use of a control group, a free-living study population, and the objective measure of the nutrient profile of shopping baskets. Although the majority of participants were female and of white race/ethnicity, the population was moderately diverse according to income and highest educational attainment. Fifty-one participants had less than a college degree and there was a broad distribution across annual household income level. To account for family size, annual income was expressed as a percent of the federal poverty guideline and a density approach was used for shopping basket nutrient analysis (i.e., g/1000 kcal or USDA servings/1000 kcal).

To analyze the nutrient profiles of food purchases, foods were accounted for via receipt analysis and digital photographs. NDSR (Nutrition Coordinating Center, Minneapolis, MN) was used to analyze the nutrient content of food purchases. The nutrient database of NDSR includes over 18,000 foods including 7,000 brand name products. The program is capable of providing values for 160 nutrient, nutrient ratios, and other food components. It also provides food group assignments and servings according to USDA standardized measurement. Data collection occurred over four months but was scheduled such that shopping for holidays could be avoided (ie. Labor Day, Halloween,

and Thanksgiving). Approximately 92% of the intervention (education) sessions were given by the same individual to minimize bias attributable to study management.

Study limitations include the short-term study design, the absence of baseline measures, the inability to account for specific food sales, and bias due to economic distress during a recession that began in 2008. We were unable to ascertain whether the shopping occasion assessed for our study was representative of usual shopping behavior. Further, purchases during our study reflect only a proportion of all household food purchases since many participants shop at other retail stores. Although baseline measures were not assessed, the inclusion of a control group minimizes bias due to pre-existing characteristics. With the exception of a borderline difference in annual household income ($p=0.044$), there were no group differences in descriptive characteristics (Table 1). We were also unable to determine whether food purchases reflected actual dietary consumption, however, Ransley et al. (2001) reported that supermarket receipts accurately predicted dietary intake.

Conclusion

This pilot study demonstrated the feasibility of conducting a supermarket intervention to promote purchasing of low-fat foods, fruits, and vegetables at the point-of-purchase. Participants who received the healthy shopping intervention purchased more servings of fruit (per 1000 kcal) when compared to those who did not receive the intervention. The success of supermarket interventions that use POP strategies depends on many factors, including cooperation of supermarket management and employees, research design and implementation, and consumer interest in POP programs. Further

encouraging the feasibility of supermarket interventions, supermarket shoppers have expressed the importance of POP settings assuming a responsibility in promoting healthy nutrition (Vermeer, Steenhuis, & Seidell, 2009).

Long-term evaluations of POP supermarket interventions should be conducted to improve the evidence base, as well as to determine the level of impact on weight loss or weight maintenance. There is also a need to test the POP programs that are already being implemented in supermarkets all over the country. Empirical data that reports the successful characteristics of supermarket interventions will help increase future funding of such programs; and will help increase support from supermarkets, surrounding communities, dieticians and health educators. If we, as researchers, are able to provide useful evidence to policy makers and food providers, decision makers will be equipped with the most appropriate knowledge to help reduce poor nutrition, obesity, and risk for chronic disease through this type of environmental modality.

TablesTable 1. Descriptive characteristics according to shopping intervention group^a

Characteristics	Intervention group (n=70)	Control group (n=83)	All participants (n=153)
Age (y) ^b	43 (24)	41 (18)	41 (21)
Sex [n (%)]			
Female	59 (84)	64 (77)	123 (81)
Male	11 (16)	19 (23)	30 (19)
Height (cm) ^b	165 (12)	165 (15)	165 (13)
Weight (kg) ^b	75 (27)	77 (25)	77 (27)
Body mass index (kg/m ²) ^b	27.7 (9.2)	27.4 (7.4)	27.6 (8.9)
Race/ ethnicity [n (%)]			
White	52 (74)	68 (82)	120 (78)
Hispanic/Latino	11 (16)	10 (12)	21 (14)
Black or African-American	3 (4)	1 (1)	4 (3)
Highest educational attainment [n(%)]			
<College	10 (14)	20 (24)	30 (20)
College	11 (16)	18 (22)	29 (19)
Graduate degree			
Annual household income [n (%)]			
<30,000	7 (10)	9 (11)	16 (10)
30,000-59,999	24 (34)	20 (24)	44 (29)
60,000-99,999	22 (32)	34 (41)	56 (37)
≥100,000	11 (16)	13 (16)	24 (16)
Prefer not to answer	6 (8)	6 (8)	12 (8)
Percent Federal Poverty ^{a,b}	295 (197)	355 (219)	322 (238)
No. of people in household ^b			
Children (≤18 y)	1 (2)	1 (2)	1 (2)
Adults	2 (0)	2 (0)	2 (0)
Shopping occasions/month ^b	8 (6)	8 (6)	8 (7)
Fast food visits/month ^b	2 (4)	3 (3)	3 (3)
Restaurants visits/month ^b	2 (3)	2 (3)	2 (3)
(sit-down/carry-out)			
Fruit intake (times/wk) ^{b,c}	5 (4)	6 (3)	6 (3)
Fruit juice intake (times/wk) ^{b,c}	3 (5)	2 (5)	3 (4)
Vegetable intake (times/wk) ^{b,c}	7 (6)	7 (5)	7 (5)

^a Non-parametric Mann-Whitney U tests were used to determine differences in descriptive characteristics by group. The control group reported a greater percent of the

federal poverty guideline ($p=0.044$) when compared to the intervention group. No other group differences were found.

^b Values are medians; interquartile range in parentheses.

^c Fruit, fruit juice, and vegetable intake questions were modified from Module 16 of the Centers for Disease Control and Prevention (CDC). *Behavioral Risk Factor Surveillance System Survey Questionnaire*. Atlanta, Georgia: US Department of Health and Human Services, Centers for Disease Control and Prevention, 2007.

Table 2. Nutrient profile of food purchases according to shopping intervention group^{a,c}

Nutrient profile ^b	Intervention (n=70)	Control (n=83)	Mann- Whitney U	z	P value	Eta- squared
Energy kcal/100 g	114 (67)	115 (67)	2611	-1.07	0.282	0.1
Total fat						
g/1000 kcal	39 (19)	39 (19)	2855	-0.18	0.855	0.0
% energy cart	35 (17)	35 (17)	2855	-0.18	0.855	0.0
Saturated fat						
g/1000 kcal	14 (9)	14 (9)	2662	-0.89	0.374	0.1
% energy cart	12 (9)	12 (8)	2662	-0.89	0.374	0.1
Trans fat						
g/1000 kcal	1.5 (1.2)	1.5 (1.2)	2813	-0.34	0.736	0.0
% energy cart	1 (1)	1 (1)	2813	-0.34	0.736	0.0
Fruit						
Servings/1000 kcal	0.7 (0.9)	0.4 (0.7)	2079	-3.03	0.002*	0.3
Fruit juice						
Servings/1000 kcal	0.0 (0.0)	0.0 (0.4)	2536	-1.58	0.114	0.1
Vegetables						
Servings/1000 kcal	1.3 (2.2)	1.0 (1.7)	2494	-1.51	0.132	0.1
Dark green/deep yellow vegetables						
Servings/1000 kcal	0.2 (0.5)	0.1 (0.5)	2545	-1.35	0.177	0.1

^a Values are medians; interquartile range in parentheses.

^b Nutrient and food calculations of shopping cart were performed using the Nutrient Data System for Research (NDSR) Nutrition Coordinating Center, Minneapolis, MN.

^c Statistics performed using non-parametric Mann-Whitney U test.

* Statistically significant at the $p<0.01$ level.

Table 3. Nutrient profile of food purchases according to income level (percent federal poverty line) and intervention group (n=141)

Nutrient/food ^b	≤244% (Lower) (n=50)		245-385% (Middle) (n=42)		≥386% (High) (n=49)	
	M	SD	M	SD	M	SD
<i>Energy density</i> (kcal/100 g)	103.85	37.79	143.30	43.82	103.10	46.96
Treatment	139.98	55.84	120.38	55.87	127.26	60.93
Control						
<i>Total fat^c</i> (g/1000 kcal)	37.61	13.13	49.54	14.13	35.85	11.72
Treatment	43.28	17.11	42.08	16.17	42.32	14.79
Control						
<i>Saturated fat^c</i> (g/1000 kcal)	13.34	6.70	16.85	5.37	11.80	4.75
Treatment	14.28	6.46	15.58	5.76	14.53	5.82
Control						
<i>Trans fat^c</i> (g/1000 kcal)	1.74	0.86	1.67	0.71	1.43	0.80
Treatment	1.61	0.93	1.61	0.77	1.57	0.81
Control						
<i>Fruit^d</i> (servings/1000 kcal)	0.77	0.95	0.77	0.47	1.22	0.94
Treatment	0.71	0.71	0.38	0.33	0.53	0.57
Control						
<i>Fruit juice^d</i> (servings/1000 kcal)	0.26	0.52	0.23	0.49	0.17	0.54
Treatment	0.25	0.39	0.40	1.08	0.25	0.46
Control						
<i>Vegetables^d</i> (servings/1000 kcal)	1.68	1.39	1.69	1.24	3.04	2.64
Treatment	1.20	1.45	1.39	1.54	2.42	1.97
Control						
<i>Dark green/ yellow vegetables^d</i> (servings/1000 kcal)	0.23	0.33	0.44	0.49	0.85	1.44
Treatment	0.16	0.22	0.18	0.44	0.47	0.57
Control						

^a Values are means and standard deviations.

^b Nutrient and food calculations of shopping cart were performed using the Nutrient Data System for Research (NDSR), Nutrition Coordinating Center, Minneapolis, MN.

Table 4. Analysis of variance comparing food purchases by income level (percent federal poverty line) and intervention group*

Nutrient profile [†]	Income ^{**}			P value	Intervention group		P value
	≤244% (Lower) (n=50)	245-385% (Middle) (n=42)	≥386% (High) (n=49)		Intervention	Control	
<i>Energy density</i> [†] (kcal/100 g)	120.47 ± 49.89	130.21 ± 51.76	117.89 ± 56.67	0.319	114.72 ± 45.41	128.92 ± 57.66	0.160
<i>Total fat</i> [‡] (g/1000 kcal)	40.22 ± 15.20	45.28 ± 15.60	39.81 ± 13.92	0.084	40.44 ± 14.06	42.53 ± 15.73	0.535
<i>Saturated fat</i> (g/1000 kcal)	13.77 ± 6.54 ^a	16.12 ± 5.56 ^b	13.47 ± 5.54 ^a	0.045	13.87 ± 6.06	14.78 ± 5.94	0.429
<i>Trans fat</i> (g/1000 kcal)	1.68 ± 0.85	1.64 ± 0.73	1.52 ± 0.80	0.546	1.63 ± 0.80	1.60 ± 0.83	0.935
<i>Fruit</i> (servings/1000 kcal)	0.74 ± 0.0.84	0.55 ± 0.44	0.80 ± 0.80	0.141	0.90 ± 0.86	0.54 ± 0.57	0.002
<i>Fruit juice</i> (servings/1000 kcal)	0.25 ± 0.39	0.33 ± 0.87	0.22 ± 0.49	0.724	0.23 ± 0.51	0.30 ± 0.70	0.459
<i>Vegetables</i> (servings/1000 kcal)	1.46 ± 1.42 ^a	1.52 ± 1.41 ^a	2.66 ± 2.25 ^b	0.001	2.09 ± 1.89	1.73 ± 1.77	0.123

<i>Dark green/ yellow vegetables (servings/1000 kcal)</i>	0.20 ± 0.28 ^a	0.29 ± 0.47	0.62 ± 1.00 ^b	0.002	0.47 ± 0.88	0.29 ± 0.47	0.039
---	--------------------------	-------------	--------------------------	-------	-------------	-------------	-------

Note: Data were analyzed using two-way analysis of variance and Bonferroni's post hoc test.

[†]Values are means and standard deviations; nutrient and food calculations of shopping cart were performed using the Nutrient Data System for Research (NDSR) Nutrition Coordinating Center, Minneapolis, MN.

[‡]Significant difference for the interaction (intervention and income; p=0.020). Purchases were higher in energy density (kcal/100 g) among those in the intervention group and of lower income when compared to middle income (p=0.039). Purchases were also lower in energy density among lower income participants in the intervention group when compared to lower income participants in the control group (p=0.015).

[‡]Borderline significant difference for the interaction (intervention and income; p=0.050). Purchases were higher in fat density (g/1000 kcal) among those in the intervention group and of middle income when compared to lower (p=0.026) and higher (p=0.016) income groups.

*Different superscripts within the same row indicate significant differences.

**Income groups are arranged by percent of the federal poverty guideline. For example, 250% of the federal poverty guideline represents an annual income of \$55,135.00 for a family of four.

References

- Ammerman, A. S., Lindquist, C. H., Lohr, K. N., & Hersey, J. (2002). The efficacy of behavioral interventions to modify dietary fat and fruit and vegetable intake: A review of the evidence. *Preventive Medicine, 35*(1), 25-41.
- Bull, F.C., Armstrong, T.P., Dixon, T., Ham, S., Neiman, A., & Pratt, M. (2004). Physical inactivity. In *Comparative quantification of health risks: global and regional burden of disease attributable to selected major risk factors*. Vol 1. Geneva, World Health Organization, pp. 729-883.
- Cheadle, A., Psaty, B. M., Curry, S., Wagner, E., Diehr, P., Koepsell, T., & Kristal, A. (1991). Community-level comparisons between the grocery store environment and individual dietary practices. *Preventive Medicine, 20*(2), 250-261.
- Cohen, J.W. (1988). *Statistical power analysis for the behavioral sciences* (2nd Ed). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Ernst, N. D., Wu, M., Frommer, P., Katz, E., Matthews, O., Moskowitz, J., Pinsky, J. L., Pohl, S., Schreiber, G. B., & Sondik, E. (1986). Nutrition education at the point of purchase: The foods for health project evaluated. *Preventive Medicine, 15*(1), 60-73.
- Flegal, K. M., Carroll, M. D., Ogden, C. L., & Curtin, L. R. (2010). Prevalence and trends in obesity among US adults, 1999-2008. *JAMA : The Journal of the American Medical Association, 303*(3), 235-241. doi:10.1001/jama.2009.2014
- Food Marketing Institute. (2001). *Trends: Consumer attitudes and the supermarket*. Washington, DC: Food Marketing Institute.
- Food Marketing Institute. (2010). *Industry Overview 2008: Supermarket facts*. Retrieved March 24, 2010, from the Food Marketing Institute Official Website: http://www.fmi.org/facts_figs/?fuseaction=superfact.
- Galobardes, B., Morabia, A., & Bernstein, M. S. (2001). Diet and socioeconomic position: Does the use of different indicators matter? *International Journal of Epidemiology, 30*(2), 334-340.
- Giskes, K., Turrell, G., van Lenthe, F. J., Brug, J., & Mackenbach, J. P. (2006). A multilevel study of socio-economic inequalities in food choice behaviour and dietary intake among the dutch population: The GLOBE study. *Public Health Nutrition, 9*(1), 75-83.

- Giskes, K., Van Lenthe, F. J., Brug, J., Mackenbach, J. P., & Turrell, G. (2007). Socioeconomic inequalities in food purchasing: The contribution of respondent-perceived and actual (objectively measured) price and availability of foods. *Preventive Medicine, 45*(1), 41-48. doi:10.1016/j.ypmed.2007.04.007
- Gittelsohn, J., Vijayadeva, V., Davison, N., Ramirez, V., Cheung, L. W., Murphy, S., & Novotny, R. (2010). A food store intervention trial improves caregiver psychosocial factors and children's dietary intake in Hawaii. *Obesity (Silver Spring, Md.), 18 Suppl 1*, S84-90. doi:10.1038/oby.2009.436
- Glanz, K., & Yaroch, A. L. (2004). Strategies for increasing fruit and vegetable intake in grocery stores and communities: policy, pricing, and environmental change. *Preventive Medicine, 39 Suppl 2*, S75-80. doi:10.1016/j.ypmed.2004.01.004
- Hunt, M. K., Lefebvre, R. C., Hixson, M. L., Banspach, S. W., Assaf, A. R., & Carleton, R. A. (1990). Pawtucket heart health program point-of-purchase nutrition education program in supermarkets. *American Journal of Public Health, 80*(6), 730-732.
- Inman, J.J., & Winer, R.S. (1998). Where the rubber meets the road: a model of in-store consumer decision making. Working paper, pp. 98-122. Retrieved April 1, 2010, from the Marketing Science Institute Official Website: <http://www.msi.org>.
- Kristal, A. R., Goldenhar, L., Muldoon, J., & Morton, R. F. (1997). Evaluation of a supermarket intervention to increase consumption of fruits and vegetables. *American Journal of Health Promotion : AJHP, 11*(6), 422-425.
- Lang, J. E., Mercer, N., Tran, D., & Mosca, L. (2000). Use of a supermarket shelf-labeling program to educate a predominately minority community about foods that promote heart health. *Journal of the American Dietetic Association, 100*(7), 804-809. doi:10.1016/S0002-8223(00)00234-0
- Matson-Koffman, D. M., Brownstein, J. N., Neiner, J. A., & Greaney, M. L. (2005). A site-specific literature review of policy and environmental interventions that promote physical activity and nutrition for cardiovascular health: What works? *American Journal of Health Promotion : AJHP, 19*(3), 167-193.
- McCullough, M. L., Feskanich, D., Stampfer, M. J., Giovannucci, E. L., Rimm, E. B., Hu, F. B., Spiegelman, D., Hunter, D. J., Colditz, G. A., & Willett, W. C. (2002). Diet quality and major chronic disease risk in men and women: Moving toward improved dietary guidance. *The American Journal of Clinical Nutrition, 76*(6), 1261-1271.
- Monsivais, P., & Drewnowski, A. (2009). Lower-energy-density diets are associated with higher monetary costs per kilocalorie and are consumed by women of higher

- socioeconomic status. *Journal of the American Dietetic Association*, 109(5), 814-822. doi:10.1016/j.jada.2009.02.002
- Mullie, P., Clarys, P., Hulens, M., & Vansant, G. (2010). Dietary patterns and socioeconomic position. *European Journal of Clinical Nutrition*, 64(3), 231-238. doi:10.1038/ejcn.2009.145
- Newby, P. K., Muller, D., Hallfrisch, J., Andres, R., & Tucker, K. L. (2004). Food patterns measured by factor analysis and anthropometric changes in adults. *The American Journal of Clinical Nutrition*, 80(2), 504-513.
- Ni Mhurchu, C., Blakely, T., Jiang, Y., Eyles, H. C., & Rodgers, A. (2010). Effects of price discounts and tailored nutrition education on supermarket purchases: A randomized controlled trial. *The American Journal of Clinical Nutrition*, 91(3), 736-747. doi:10.3945/ajcn.2009.28742
- Ogden, C. L., Carroll, M. D., McDowell, M. A., & Flegal, K. M. (2007). Obesity among adults in the united states--no statistically significant change since 2003-2004. *NCHS Data Brief*, (1)(1), 1-8.
- O'Loughlin, J., Ledoux, J., Barnett, T., & Paradis, G. (1996). La commande du coeur ("shop for your heart"): A point-of-choice nutrition education campaign in a low-income urban neighborhood. *American Journal of Health Promotion : AJHP*, 10(3), 175-178.
- Paine-Andrews, A., Francisco, V. T., Fawcett, S. B., Johnston, J., & Coen, S. (1996). Health marketing in the supermarket: Using prompting, product sampling, and price reduction to increase customer purchases of lower-fat items. *Health Marketing Quarterly*, 14(2), 85-99.
- Rodgers, A. B., Kessler, L. G., Portnoy, B., Potosky, A. L., Patterson, B., Tenney, J., Thompson, F. E., Krebs-Smith, S. M., Breen, N., & Mathews, O. (1994). "Eat for health": A supermarket intervention for nutrition and cancer risk reduction. *American Journal of Public Health*, 84(1), 72-76.
- Roos, E., Prattala, R., Lahelma, E., Kleemola, P., & Pietinen, P. (1996). Modern and healthy?: Socioeconomic differences in the quality of diet. *European Journal of Clinical Nutrition*, 50(11), 753-760.
- Sallis, J.F., & Owen, N. (2002). Ecological models of health behavior. In: Glanz K, Lewis FM, Rimer BK, (Eds). *Health behavior and health education: theory, research, and practice*. Third ed. San Francisco, CA: Jossey-Bass. pp. 462-84.

- Seymour, J. D., Yaroch, A. L., Serdula, M., Blanck, H. M., & Khan, L. K. (2004). Impact of nutrition environmental interventions on point-of-purchase behavior in adults: A review. *Preventive Medicine, 39 Suppl 2*, S108-36.
doi:10.1016/j.jpmed.2004.04.002
- Sutherland, L. A., Kaley, L. A., & Fischer, L. (2010). Guiding stars: The effect of a nutrition navigation program on consumer purchases at the supermarket. *The American Journal of Clinical Nutrition, 91*(4), 1090S-1094S.
doi:10.3945/ajcn.2010.28450C
- US Department of Health and Human Services (USDHHS), & US Department of Agriculture (USDA). (2005). *Dietary guidelines for Americans 2005*. Retrieved March 15, 2008, from the USDHHS Official Website:
<http://www.healthierus.gov/dietaryguidelines>.
- US Department of Health and Human Services (USDHHS), & Assistant Secretary for Planning and Evaluation (ASPE). (2010). Poverty guidelines, research, and measurement. Retrieved May 1, 2010, from the ASPE Official Website:
<http://aspe.hhs.gov/poverty>.
- Vermeer, W. M., Steenhuis, I. H., & Seidell, J. C. (2009). From the point-of-purchase perspective: A qualitative study of the feasibility of interventions aimed at portion-size. *Health Policy (Amsterdam, Netherlands), 90*(1), 73-80.
doi:10.1016/j.healthpol.2008.07.006
- World Health Organization. (2010). Chronic Diseases and Health Promotion. Retrieved May 1, 2010, from the World Health Organization Official Website:
<http://www.who.int/chp/en>.

Chapter 6

Conclusion

The International Obesity Task Force uses an ecological approach to guide efforts to prevent worldwide obesity (Kumanyika et al., 2010). This approach suggests three main influences on equilibrium levels of body fat. Biological influences include unalterable factors such as age, sex, hormones, and genetics (Katahn & McMinn, 1990). Behavioral factors encompass habits, emotions, attitudes, beliefs, and cognitions (Brownell & Wadden, 1992). The third component, the environment, is divided into microenvironmental settings (the setting where the behavior takes place such as the supermarket), and macroenvironmental settings (such as the food service industry) (Egger & Swinburn, 1997; Booth et al., 2001). Aligned with the ecological perspective described by Egger and Swinburn (1997), four studies were designed to investigate the influences of obesity. Although the studies do not address each component of the ecological model, this approach was used when developing the studies.

The first study (Chapter 2) considered biological and behavioral influences of obesity and aimed to assess dietary quality among Hispanic and non-Hispanic premenopausal women. The secondary objective was to examine the relationship between dietary quality and markers of obesity. Using 7-day dietary records, dietary quality was determined using the Healthy Eating Index (HEI)-2005. The results of this study found a lower overall dietary quality among Hispanic women when compared to non-Hispanic white women. Hispanic women in this study also had a lower intake of

total vegetables and dark green and orange vegetables and legumes, and a higher sodium intake. Interestingly, there were no significant differences in absolute reported dietary intake (macronutrients and energy), and this finding warrants future investigation. The difference in total vegetables intake between the groups was equivalent to one cup per week. This finding supports previous research that suggests small, incremental changes in food choices significantly improved dietary quality (Hornick, Krester, & Nickals, 2008). These findings also suggest that nutrition interventions aimed toward Hispanic women should focus on increasing vegetable and limiting sodium consumption. Both groups in this study also did not meet the Institute of Medicine's recommendation for all adults to have a total HEI-2005 score of 80 or above [Institute of Medicine (IOM), 2008].

The second and third studies (chapters 3 and 4) addressed the behavioral and environmental components of the ecological perspective (Egger & Swinburn, 1997). The environmental component in these studies was the influence of television viewing and computer use. The second study (chapter 3) examined the relationship between reported screen time and markers of obesity and found a higher body mass index, waist circumference, and total percent body fat among individuals who engaged in more time in front of the television and computer. We also reported that greater than three hours of screen time deleteriously influenced markers of obesity among premenopausal women, independent of reported physical activity. In addition to meeting daily physical activity guidelines, adults should aim to reduce time spent in front of the screen to fewer than

three hours per day. This recommendation is also supported by the new 2010 Dietary Guidelines Advisory Committee report.

The third study (chapter 4) examined the relationship between screen time and dietary intake because eating while watching television may be a potential mechanism linking screen time to obesity. Although absolute dietary intake was not significantly different between screen time groups, a greater percentage of dietary intake was consumed during screen time among those in the highest screen time category. To encourage long-term behavior change, interventions aiming to reduce sedentary behaviors should perhaps first promote the avoidance of eating during sedentary behaviors, and second, the reduction in time spent in sedentary behaviors (Stroebele et al., 2009).

The fourth study (chapter 5) addressed microenvironmental influences of obesity by using the supermarket as an intervention setting. It also addressed behavioral factors such as purchasing behaviors and food choice. The purpose of the study was to pilot test a brief face-to-face healthy shopping intervention to determine whether food purchases of participants who received the intervention differed from those in the control group. Participants who received the intervention purchased more servings of fruit when compared to those who did not receive the intervention. There is a need to continue testing supermarket nutrition programs that are currently implemented. Empirical data that reports the successful characteristics of supermarket interventions will help increase

future funding of such programs and will help shape future policy addressing obesity by informing policy makers.

The findings of all four studies suggest that obesity is a complex, multifactorial health condition. Nutrition interventions to prevent or reduce obesity should be designed based upon an ecological framework with the intent of building the empirical research base and informing policy makers. Nutrition policy, and recommendations for the American population, should continue to focus on promoting fruit and vegetable consumption, and reducing sedentary behaviors, such as television viewing.

REFERENCES

- Achabal, D.D., McIntyre, S.H., Bell, C.H., & Tucker, N. (1987). The effect of nutrition P-O-P signs on consumer attitudes and behavior. *Journal of Retail*, 63, 9-24.
- Ainsworth, B. E., Haskell, W. L., Leon, A. S., Jacobs, D. R., Jr, Montoye, H. J., Sallis, J. F., & Paffenbarger, R. S., Jr. (1993). Compendium of physical activities: Classification of energy costs of human physical activities. *Medicine and Science in Sports and Exercise*, 25(1), 71-80.
- American Academy of Pediatrics. (2001). Committee on Public Education. American Academy of Pediatrics: Children, adolescents, and television. *Pediatrics*, 107(2), 423-426.
- Ammerman, A. S., Lindquist, C. H., Lohr, K. N., & Hersey, J. (2002). The efficacy of behavioral interventions to modify dietary fat and fruit and vegetable intake: A review of the evidence. *Preventive Medicine*, 35(1), 25-41.
- Anderson, L. H., Martinson, B. C., Crain, A. L., Pronk, N. P., Whitebird, R. R., O'Connor, P. J., & Fine, L. J. (2005). Health care charges associated with physical inactivity, overweight, and obesity. *Preventing Chronic Disease*, 2(4), A09.
- Arizona Department of Health Services. (2007). Differences in the health status among race/ethnic groups, Arizona, 2007. Retrieved March 19th, 2009, from the Arizona Department of Health Services Official Website: <http://www.azdhs.gov/plan/report/dhsag/dhsag07/index.htm>.
- Ashwell, M. (2009). Obesity risk: Importance of the waist-to-height ratio. *Nursing Standard (Royal College of Nursing (Great Britain))* : 1987, 23(41), 49-54; quiz 55.
- Ashwell, M., & Hsieh, S. D. (2005). Six reasons why the waist-to-height ratio is a rapid and effective global indicator for health risks of obesity and how its use could simplify the international public health message on obesity. *International Journal of Food Sciences and Nutrition*, 56(5), 303-307.
doi:10.1080/09637480500195066
- Basiotis, P.P., Carlson, A., Gerrior, S.A., Juan, W.Y., & Lino, M. (2002). The Healthy Eating Index: 1999-2000. CNPP-12. Retrieved September 1, 2008, from the US Department of Agriculture, Center for Nutrition Policy and Promotion Official Website: <http://www.cnpp.usda.gov/>

- Bellisle, F., Dalix, A. M., & Slama, G. (2004). Non food-related environmental stimuli induce increased meal intake in healthy women: Comparison of television viewing versus listening to a recorded story in laboratory settings. *Appetite*, *43*(2), 175-180. doi:10.1016/j.appet.2004.04.004
- Bennett, G. G., Wolin, K. Y., Viswanath, K., Askew, S., Puleo, E., & Emmons, K. M. (2006). Television viewing and pedometer-determined physical activity among multiethnic residents of low-income housing. *American Journal of Public Health*, *96*(9), 1681-1685. doi:10.2105/AJPH.2005.080580
- Blass, E. M., Anderson, D. R., Kirkorian, H. L., Pempek, T. A., Price, I., & Koleini, M. F. (2006). On the road to obesity: Television viewing increases intake of high-density foods. *Physiology & Behavior*, *88*(4-5), 597-604. doi:10.1016/j.physbeh.2006.05.035
- Booth, S. L., Sallis, J. F., Ritenbaugh, C., Hill, J. O., Birch, L. L., Frank, L. D., Glanz, K., Himmelgreen, D. A., Mudd, M., Popkin, B. M., Rickard, K. A., St Jeor, S., & Hays, N. P. (2001). Environmental and societal factors affect food choice and physical activity: Rationale, influences, and leverage points. *Nutrition Reviews*, *59*(3 Pt 2), S21-39; discussion S57-65.
- Borzekowski, D. L., & Robinson, T. N. (2001). The 30-second effect: An experiment revealing the impact of television commercials on food preferences of preschoolers. *Journal of the American Dietetic Association*, *101*(1), 42-46. doi:10.1016/S0002-8223(01)00012-8
- Bowman, S. A. (2006). Television-viewing characteristics of adults: Correlations to eating practices and overweight and health status. *Preventing Chronic Disease*, *3*(2), A38.
- Boynton, A., Neuhauser, M. L., Sorensen, B., McTiernan, A., & Ulrich, C. M. (2008). Predictors of diet quality among overweight and obese postmenopausal women. *Journal of the American Dietetic Association*, *108*(1), 125-130. doi:10.1016/j.jada.2007.10.037
- Brownell, K. D., & Wadden, T. A. (1992). Etiology and treatment of obesity: Understanding a serious, prevalent, and refractory disorder. *Journal of Consulting and Clinical Psychology*, *60*(4), 505-517.
- Bull, F.C., Armstrong, T.P., Dixon, T., Ham, S., Neiman, A., & Pratt, M. (2004). Physical inactivity. In *Comparative quantification of health risks: global and regional burden of disease attributable to selected major risk factors*. Vol 1. Geneva, World Health Organization, pp. 729-883.

- Carrera, P. M., Gao, X., & Tucker, K. L. (2007). A study of dietary patterns in the mexican-american population and their association with obesity. *Journal of the American Dietetic Association*, 107(10), 1735-1742.
doi:10.1016/j.jada.2007.07.016
- Centers for Disease Control and Prevention (2009). 2008 Physical activity guidelines for Americans. Fact sheet for health professionals on physical activity guidelines for adults. Retrieved April 1, 2010, from Centers for Disease Control and Prevention Official Website:
http://www.cdc.gov/nccdphp/dnpa/physical/health_professionals/reports/index.htm
- Centers for Disease Control and Prevention. (2009). Morbidity and Mortality Weekly Report (MMWR): Recommended community strategies and measurements to prevent obesity in the United States. Retrieved April 13, 2010, from Centers for Disease Control and Prevention Official Website: <http://www.cdc.gov/mmwr>
- Center for Disease Control and Prevention. (2009). Recommended community strategies and measurements to prevent obesity in the United States. *MMWR*, 58(No. RR-7).
- Centers for Disease Control and Prevention. National Center for Health Statistics. National Health and Nutrition Examination Survey. Retrieved May 27, 2010, from the Centers for Disease Control and Prevention Official Website:
<http://www.cdc.gov/nchs/nhanes/>
- Chamberlain, L. J., Wang, Y., & Robinson, T. N. (2006). Does children's screen time predict requests for advertised products? Cross-sectional and prospective analyses. *Archives of Pediatrics & Adolescent Medicine*, 160(4), 363-368.
doi:10.1001/archpedi.160.4.363
- Cheadle, A., Psaty, B. M., Curry, S., Wagner, E., Diehr, P., Koepsell, T., & Kristal, A. (1991). Community-level comparisons between the grocery store environment and individual dietary practices. *Preventive Medicine*, 20(2), 250-261.
- Cohen, J.W. (1988). *Statistical power analysis for the behavioral sciences* (2nd Ed). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Coon, K. A., Goldberg, J., Rogers, B. L., & Tucker, K. L. (2001). Relationships between use of television during meals and children's food consumption patterns. *Pediatrics*, 107(1), E7.
- Coulston, A. M. (2001). The search continues for a tool to evaluate dietary quality. *The American Journal of Clinical Nutrition*, 74(4), 417.

- Cox, B. D., & Whichelow, M. (1996). Ratio of waist circumference to height is better predictor of death than body mass index. *BMJ (Clinical Research Ed.)*, *313*(7070), 1487.
- Daly, A., Evert, A., Franz, M.J. et al. (2008). *Choose Your Foods: Exchange Lists for Diabetes*. Alexandria, VA: American Diabetes Association.
- DeMattia, L., Lemont, L., & Meurer, L. (2007). Do interventions to limit sedentary behaviours change behaviour and reduce childhood obesity? A critical review of the literature. *Obesity Reviews : An Official Journal of the International Association for the Study of Obesity*, *8*(1), 69-81. doi:10.1111/j.1467-789X.2006.00259.x
- Egger, G., Pearson, S., Pal, S., & Swinburn, B. (2007). Dissecting obesogenic behaviours: The development and application of a test battery for targeting prescription for weight loss. *Obesity Reviews : An Official Journal of the International Association for the Study of Obesity*, *8*(6), 481-486. doi:10.1111/j.1467-789X.2007.00395.x
- Egger, G., & Swinburn, B. (1997). An "ecological" approach to the obesity pandemic. *BMJ (Clinical Research Ed.)*, *315*(7106), 477-480.
- Ernst, N. D., Wu, M., Frommer, P., Katz, E., Matthews, O., Moskowitz, J., Pinsky, J. L., Pohl, S., Schreiber, G. B., & Sondik, E. (1986). Nutrition education at the point of purchase: The foods for health project evaluated. *Preventive Medicine*, *15*(1), 60-73.
- Ervin, R. B. (2008). Healthy eating index scores among adults, 60 years of age and over, by sociodemographic and health characteristics: United states, 1999-2002. *Advance Data*, *(395)*(395), 1-16.
- Finkelstein, E. A., Fiebelkorn, I. C., & Wang, G. (2003). National medical spending attributable to overweight and obesity: How much, and who's paying? *Health Affairs (Project Hope), Suppl Web Exclusives*, W3-219-26.
- Fitzgerald, A. L., Dewar, R. A., & Veugelers, P. J. (2002). Diet quality and cancer incidence in Nova Scotia, Canada. *Nutrition and Cancer*, *43*(2), 127-132.
- Flegal, K.M. (2005). Epidemiologic aspects of overweight and obesity in the United States. *Physiology & Behavior*, *46*:599-602.

- Flegal, K.M., Graubard, B.I., Williamson, D.F., & Gail, M.H. (2007). Cause-specific excess deaths associated with underweight, overweight, and obesity. *JAMA: Journal of the American Medical Association*, 298(17):2028-2037.
- Flegal, K. M., Carroll, M. D., Ogden, C. L., & Curtin, L. R. (2010). Prevalence and trends in obesity among US adults, 1999-2008. *JAMA : The Journal of the American Medical Association*, 303(3), 235-241. doi:10.1001/jama.2009.2014
- Food Marketing Institute. (2001). Trends: Consumer attitudes and the supermarket. Washington, DC: Food Marketing Institute.
- Food Marketing Institute. (2010). Industry Overview 2008: Supermarket facts. Retrieved March 24, 2010, from the Food Marketing Institute Official Website: http://www.fmi.org/facts_figs/?fuseaction=superfact.
- Ford, E. S., Will, J. C., De Proost Ford, M. A., & Mokdad, A. H. (1998). Health insurance status and cardiovascular disease risk factors among 50-64-year-old US women: Findings from the third national health and nutrition examination survey. *Journal of Women's Health / the Official Publication of the Society for the Advancement of Women's Health Research*, 7(8), 997-1006.
- Fulton, J. E., Wang, X., Yore, M. M., Carlson, S. A., Galuska, D. A., & Caspersen, C. J. (2009). Television viewing, computer use, and BMI among US children and adolescents. *Journal of Physical Activity & Health*, 6 Suppl 1, S28-35.
- Fung, T. T., Hu, F. B., Yu, J., Chu, N. F., Spiegelman, D., Tofler, G. H., Willett, W. C., & Rimm, E. B. (2000). Leisure-time physical activity, television watching, and plasma biomarkers of obesity and cardiovascular disease risk. *American Journal of Epidemiology*, 152(12), 1171-1178.
- Galobardes, B., Morabia, A., & Bernstein, M. S. (2001). Diet and socioeconomic position: Does the use of different indicators matter? *International Journal of Epidemiology*, 30(2), 334-340.
- Gao, S. K., Beresford, S. A., Frank, L. L., Schreiner, P. J., Burke, G. L., & Fitzpatrick, A. L. (2008). Modifications to the Healthy Eating Index and its ability to predict obesity: The multi-ethnic study of atherosclerosis. *The American Journal of Clinical Nutrition*, 88(1), 64-69.
- Giskes, K., Turrell, G., van Lenthe, F. J., Brug, J., & Mackenbach, J. P. (2006). A multilevel study of socio-economic inequalities in food choice behaviour and dietary intake among the Dutch population: The GLOBE study. *Public Health Nutrition*, 9(1), 75-83.

- Giskes, K., Van Lenthe, F. J., Brug, J., Mackenbach, J. P., & Turrell, G. (2007). Socioeconomic inequalities in food purchasing: The contribution of respondent-perceived and actual (objectively measured) price and availability of foods. *Preventive Medicine, 45*(1), 41-48. doi:10.1016/j.ypmed.2007.04.007
- Gittelsohn, J., Vijayadeva, V., Davison, N., Ramirez, V., Cheung, L. W., Murphy, S., & Novotny, R. (2010). A food store intervention trial improves caregiver psychosocial factors and children's dietary intake in Hawaii. *Obesity (Silver Spring, Md.), 18 Suppl 1*, S84-90. doi:10.1038/oby.2009.436
- Glanz, K., & Yaroch, A. L. (2004). Strategies for increasing fruit and vegetable intake in grocery stores and communities: Policy, pricing, and environmental change. *Preventive Medicine, 39 Suppl 2*, S75-80. doi:10.1016/j.ypmed.2004.01.004
- Gore, S. A., Foster, J. A., DiLillo, V. G., Kirk, K., & Smith West, D. (2003). Television viewing and snacking. *Eating Behaviors, 4*(4), 399-405. doi:10.1016/S1471-0153(03)00053-9
- Guenther, P. M., Reedy, J., & Krebs-Smith, S. M. (2008). Development of the Healthy Eating Index-2005. *Journal of the American Dietetic Association, 108*(11), 1896-1901. doi:10.1016/j.jada.2008.08.016
- Guenther, P. M., Reedy, J., Krebs-Smith, S. M., & Reeve, B. B. (2008). Evaluation of the Healthy Eating Index-2005. *Journal of the American Dietetic Association, 108*(11), 1854-1864. doi:10.1016/j.jada.2008.08.011
- Guenther, P.M., Juan, W.Y., Reedy, J., Britten, P., Lino, M., Carlson, A...Krebs-Smith, S. (2008). Diet quality of Americans in 1994-96 and 2001-02 as measured by the Healthy Eating Index-2005. Nutrition Insight 37. US Department of Agriculture (USDA), Center for Nutrition Policy and Promotion. Retrieved September 1st, 2008, from the USDA, Center for Nutrition Policy and Promotion Official Website: <http://www.cnpp.usda.gov/Publications/NutritionInsights/>
- Guo, X., Warden, B. A., Paeratakul, S., & Bray, G. A. (2004). Healthy Eating Index and obesity. *European Journal of Clinical Nutrition, 58*(12), 1580-1586. doi:10.1038/sj.ejcn.1601989
- Hamilton, M.T., Healy, G.N., Dunstan, D.W., Zderic, T.W., & Owen, N. (2008). Too little exercise and too much sitting: Inactivity physiology and the need for new recommendations on sedentary behavior. *Current Cardiovascular Risk Reports, 2*, 292-298. doi:10.1007

- Hann, C. S., Rock, C. L., King, I., & Drewnowski, A. (2001). Validation of the Healthy Eating Index with use of plasma biomarkers in a clinical sample of women. *The American Journal of Clinical Nutrition*, 74(4), 479-486.
- Healy, G. N., Dunstan, D. W., Salmon, J., Shaw, J. E., Zimmet, P. Z., & Owen, N. (2008). Television time and continuous metabolic risk in physically active adults. *Medicine and Science in Sports and Exercise*, 40(4), 639-645. doi:10.1249/MSS.0b013e3181607421
- Hetherington, M. M. (2007). Cues to overeat: Psychological factors influencing overconsumption. *The Proceedings of the Nutrition Society*, 66(1), 113-123. doi:10.1017/S0029665107005344
- Hornick, B. A., Krester, A. J., & Nicklas, T. A. (2008). Menu modeling with MyPyramid food patterns: Incremental dietary changes lead to dramatic improvements in diet quality of menus. *Journal of the American Dietetic Association*, 108(12), 2077-2083. doi:10.1016/j.jada.2008.09.010
- Hu, F. B., Li, T. Y., Colditz, G. A., Willett, W. C., & Manson, J. E. (2003). Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA : The Journal of the American Medical Association*, 289(14), 1785-1791. doi:10.1001/jama.289.14.1785
- Huijbregts, P., Feskens, E., Rasanen, L., Fidanza, F., Nissinen, A., Menotti, A., & Kromhout, D. (1997). Dietary pattern and 20 year mortality in elderly men in Finland, Italy, and the Netherlands: Longitudinal cohort study. *BMJ (Clinical Research Ed.)*, 315(7099), 13-17.
- Hunt, M. K., Lefebvre, R. C., Hixson, M. L., Banspach, S. W., Assaf, A. R., & Carleton, R. A. (1990). Pawtucket heart health program point-of-purchase nutrition education program in supermarkets. *American Journal of Public Health*, 80(6), 730-732.
- Inman, J.J., & Winer, R.S. (1998). Where the rubber meets the road: a model of in-store consumer decision making. Working paper, pp. 98-122. Retrieved April 1, 2010, from the Marketing Science Institute Official Website: <http://www.msi.org>.
- Institute of Medicine of the National Academies. Food and Nutrition Board. (2002). Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington, D.C.: National Academies Press.
- Institute of Medicine of the National Academies. (2008). State of the USA Health Indicators: Letter Report. Washington, D.C.: National Academies Press. Retrieved

January 15, 2009, from the Institute of Medicine of the National Academies
Official Website: <http://www.iom.edu/>

- International Food Information Council Foundation. (2004). Addressing the Obesity Debate: a consumer point of view. Retrieved March 20, 2009, from the International Food Information Council Foundation Official Website: http://www.foodinsight.org/Resources/Detail.aspx?topic=Addressing_the_Obesity_Debate_A_Consumer_Point_of_View_
- Jakes, R. W., Day, N. E., Khaw, K. T., Luben, R., Oakes, S., Welch, A., Bingham, S., & Wareham, N. J. (2003). Television viewing and low participation in vigorous recreation are independently associated with obesity and markers of cardiovascular disease risk: EPIC-norfolk population-based study. *European Journal of Clinical Nutrition*, 57(9), 1089-1096. doi:10.1038/sj.ejcn.1601648
- James, W. P. (2008). The epidemiology of obesity: The size of the problem. *Journal of Internal Medicine*, 263(4), 336-352. doi:10.1111/j.1365-2796.2008.01922.x
- Johnson, K. M., Nelson, K. M., & Bradley, K. A. (2006). Television viewing practices and obesity among women veterans. *Journal of General Internal Medicine*, 21 Suppl 3, S76-81. doi:10.1111/j.1525-1497.2006.00379.x
- Kant, A. K., Schatzkin, A., Graubard, B. I., & Schairer, C. (2000). A prospective study of diet quality and mortality in women. *JAMA : The Journal of the American Medical Association*, 283(16), 2109-2115.
- Katahn, M., & McMinn, M.R. (1990). Obesity: a biobehavioral point of view. *Annals of the New York Academy of Science*, 602, 189-204.
- Kelly, T. L., Wilson, K. E., & Heymsfield, S. B. (2009). Dual energy X-ray absorptiometry body composition reference values from NHANES. *PloS One*, 4(9), e7038. doi:10.1371/journal.pone.0007038
- Kennedy, E. T., Ohls, J., Carlson, S., & Fleming, K. (1995). The healthy eating index: Design and applications. *Journal of the American Dietetic Association*, 95(10), 1103-1108. doi:10.1016/S0002-8223(95)00300-2
- Kesaniemi, Y.K., Danforth, E. Jr., Jensen, M.D., Kopelman, P.G., Lefebvre, P., & Reeder, B.A. (2001). Dose-response issues concerning physical activity and health: an evidence-based symposium. *Medicine & Science in Sports & Exercise*, 33(6), S351-358. Retrieved April 1, 2010, from the Medicine & Science in Sports & Exercise Official Website: <http://journals.lww.com/acsm-msse/pages/default.aspx>

- Kominski, R., & Newburger, E. (1999). Access denied: Changes in computer ownership and use: 1984-1997. Population Division US Census Bureau Washington, D.C. Retrieved April 1, 2010, from the US Census Bureau Official Website: <http://www.census.gov/>
- Kristal, A. R., Goldenhar, L., Muldoon, J., & Morton, R. F. (1997). Evaluation of a supermarket intervention to increase consumption of fruits and vegetables. *American Journal of Health Promotion : AJHP*, 11(6), 422-425.
- Kristal, A. R., Shattuck, A. L., & Patterson, R. E. (1999). Differences in fat-related dietary patterns between black, Hispanic and white women: Results from the women's health trial feasibility study in minority populations. *Public Health Nutrition*, 2(3), 253-262.
- Kronenberg, F., Pereira, M. A., Schmitz, M. K., Arnett, D. K., Evenson, K. R., Crapo, R. O., Jensen, R. L., Burke, G. L., Sholinsky, P., Ellison, R. C., & Hunt, S. C. (2000). Influence of leisure time physical activity and television watching on atherosclerosis risk factors in the NHLBI family heart study. *Atherosclerosis*, 153(2), 433-443.
- Kumanyika, Jeffery, Morabia, Ritenbaugh, and Antipatis. (2010). "Obesity Prevention: The Case for Action: A Report of the Public Health Approaches to the Prevention Obesity Working Group of the International Obesity Task Force." Retrieved June 7, 2010, from the International Association for the Study of Obesity Official Website: www.iaotf.org
- Lang, J. E., Mercer, N., Tran, D., & Mosca, L. (2000). Use of a supermarket shelf-labeling program to educate a predominately minority community about foods that promote heart health. *Journal of the American Dietetic Association*, 100(7), 804-809. doi:10.1016/S0002-8223(00)00234-0
- Larkey, L. K., Day, S. H., Houtkooper, L., & Renger, R. (2003). Osteoporosis prevention: Knowledge and behavior in a southwestern community. *Journal of Community Health*, 28(5), 377-388.
- Lee, R.D., & Nieman, D.C. (2003). Measuring Diet. In *Nutritional Assessment* (3rd Ed), pp. 79-80.
- Lee, R.D., & Nieman, D.C. (2003). Anthropometry. In *Nutritional Assessment* (3rd Ed). pp. 205-206.
- Lee, R.D., & Nieman, D.C. (2007). Measuring Diet. In *Nutritional Assessment* (4th Ed). pp. 83-91. New York: McGraw-Hill.

- Lee, R.D., & Nieman, D.C. (2007). Anthropometry. In *Nutritional Assessment* (4th Ed). pp. 209-210.
- Leibel, R. L., Rosenbaum, M., & Hirsch, J. (1995). Changes in energy expenditure resulting from altered body weight. *The New England Journal of Medicine*, 332(10), 621-628.
- Liberatos, P., Link, B. G., & Kelsey, J. L. (1988). The measurement of social class in epidemiology. *Epidemiologic Reviews*, 10, 87-121.
- Lu, M., Ye, W., Adami, H. O., & Weiderpass, E. (2006). Prospective study of body size and risk for stroke amongst women below age 60. *Journal of Internal Medicine*, 260(5), 442-450. doi:10.1111/j.1365-2796.2006.01706.x
- Lu, N., Samuels, M. E., & Huang, K. C. (2002). Dietary behavior in relation to socioeconomic characteristics and self-perceived health status. *Journal of Health Care for the Poor and Underserved*, 13(2), 241-257.
- Matheson, D. M., Killen, J. D., Wang, Y., Varady, A., & Robinson, T. N. (2004). Children's food consumption during television viewing. *The American Journal of Clinical Nutrition*, 79(6), 1088-1094.
- Matson-Koffman, D. M., Brownstein, J. N., Neiner, J. A., & Greaney, M. L. (2005). A site-specific literature review of policy and environmental interventions that promote physical activity and nutrition for cardiovascular health: What works? *American Journal of Health Promotion : AJHP*, 19(3), 167-193.
- McCabe-Sellers, B. J., Bowman, S., Stuff, J. E., Champagne, C. M., Simpson, P. M., & Bogle, M. L. (2007). Assessment of the diet quality of US adults in the lower Mississippi delta. *The American Journal of Clinical Nutrition*, 86(3), 697-706.
- McCarthy, S. N., Gibney, M. J., Flynn, A., & Irish Universities Nutrition Alliance. (2002). Overweight, obesity and physical activity levels in Irish adults: Evidence from the North/South Ireland food consumption survey. *The Proceedings of the Nutrition Society*, 61(1), 3-7.
- McCullough, M. L., Feskanich, D., Stampfer, M. J., Giovannucci, E. L., Rimm, E. B., Hu, F. B., Spiegelman, D., Hunter, D. J., Colditz, G. A., & Willett, W. C. (2002). Diet quality and major chronic disease risk in men and women: Moving toward improved dietary guidance. *The American Journal of Clinical Nutrition*, 76(6), 1261-1271.

- Milewicz, A., Mikulski, E., & Bidzinska, B. (2000). Plasma insulin, cholecystokinin, galanin, neuropeptide Y and leptin levels in obese women with and without type 2 diabetes mellitus. *International Journal of Obesity*, 24, S152-S153. Retrieved April 13, 2010, from the International Journal of Obesity Official Website: <http://www.nature.com/ijo/index.html>
- Miller, S. A., Taveras, E. M., Rifas-Shiman, S. L., & Gillman, M. W. (2008). Association between television viewing and poor diet quality in young children. *International Journal of Pediatric Obesity : IJPO : An Official Journal of the International Association for the Study of Obesity*, 1-9. doi:10.1080/17477160801915935
- Mokdad, A. H., Serdula, M. K., Dietz, W. H., Bowman, B. A., Marks, J. S., & Koplan, J. P. (1999). The spread of the obesity epidemic in the United States, 1991-1998. *JAMA : The Journal of the American Medical Association*, 282(16), 1519-1522.
- Monsivais, P., & Drewnowski, A. (2009). Lower-energy-density diets are associated with higher monetary costs per kilocalorie and are consumed by women of higher socioeconomic status. *Journal of the American Dietetic Association*, 109(5), 814-822. doi:10.1016/j.jada.2009.02.002
- Mullie, P., Clarys, P., Hulens, M., & Vansant, G. (2010). Dietary patterns and socioeconomic position. *European Journal of Clinical Nutrition*, 64(3), 231-238. doi:10.1038/ejcn.2009.145
- Murtaugh, M. A., Herrick, J. S., Sweeney, C., Baumgartner, K. B., Guiliano, A. R., Byers, T., & Slattery, M. L. (2007). Diet composition and risk of overweight and obesity in women living in the southwestern United States. *Journal of the American Dietetic Association*, 107(8), 1311-1321. doi:10.1016/j.jada.2007.05.008
- National Center for Chronic Disease Prevention and Health Promotion. (2007). Behavioral Risk Factor Surveillance System. Prevalence and Trends: fruits and vegetables. Retrieved April 9, 2009, from the National Center for Chronic Disease Prevention and Health Promotion Official Website: <http://apps.nccd.cdc.gov/BRFSS/list.asp?cat=FV&yr=2007&qkey=4415&state=All>
- National Center for Chronic Disease Prevention and Health Promotion. Obesity trends among US adults between 1985 and 2008. Retrieved May 25, 2010, from the Centers for Disease Control and Prevention Official Website: www.cdc.gov/nccdphp/dnpa/obesity/
- National Center for Health Statistics. (2007). National Health and Nutrition Examination Survey 2001-2002. Documentation, Codebook, and Frequencies: Dietary

- Interview. Retrieved October 1, 2008 from the Center for Disease Control and Prevention Official Website: <http://www.cdc.gov/nchs/nhanes.htm>
- National Institutes of Health. (1998). Clinical guidelines on the identification, evaluation and treatment of overweight and obesity in adults: the evidence report. *Obes Res*;6(Suppl 2):51S-209S.
- Neuhouser, M. L., Thompson, B., Coronado, G. D., & Solomon, C. C. (2004). Higher fat intake and lower fruit and vegetables intakes are associated with greater acculturation among Mexicans living in Washington state. *Journal of the American Dietetic Association*, 104(1), 51-57. doi:10.1016/j.jada.2003.10.015
- Newby, P. K., Muller, D., Hallfrisch, J., Andres, R., & Tucker, K. L. (2004). Food patterns measured by factor analysis and anthropometric changes in adults. *The American Journal of Clinical Nutrition*, 80(2), 504-513.
- Ni Mhurchu, C., Blakely, T., Jiang, Y., Eyles, H. C., & Rodgers, A. (2010). Effects of price discounts and tailored nutrition education on supermarket purchases: A randomized controlled trial. *The American Journal of Clinical Nutrition*, 91(3), 736-747. doi:10.3945/ajcn.2009.28742
- Nielsen Media Research. (1998). Nielsen report on television, Nielsen Media Research. New York: Nielsen Media Research, AC Nielsen. Retrieved September 1, 2010, from Nielsen Media Research Official Website: <http://en-us.nielsen.com/tab/industries/media>
- Nielsen Media Research. (2007). Nielsen reports television tuning remains at record levels, digital video recorders grow in popularity. New York: Nielsen Media Research, AC Nielsen. Retrieved September 1, 2010, from Nielsen Media Research Official Website: <http://en-us.nielsen.com/tab/industries/media>
- Nielsen Media Research. (2009). A2/M2 three screen report, vol 4-6. New York: Nielsen Media Research, AC Nielsen. Retrieved September 1, 2010, from Nielsen Media Research Official Website: <http://en-us.nielsen.com/tab/industries/media>
- Ogden, C. L., Carroll, M. D., Curtin, L. R., McDowell, M. A., Tabak, C. J., & Flegal, K. M. (2006). Prevalence of overweight and obesity in the United States, 1999-2004. *JAMA : The Journal of the American Medical Association*, 295(13), 1549-1555. doi:10.1001/jama.295.13.1549
- Ogden, C. L., Carroll, M. D., McDowell, M. A., & Flegal, K. M. (2007). Obesity among adults in the United States--no statistically significant change since 2003-2004. *NCHS Data Brief*, (1)(1), 1-8.

- Ogden, C. L., Yanovski, S. Z., Carroll, M. D., & Flegal, K. M. (2007). The epidemiology of obesity. *Gastroenterology*, *132*(6), 2087-2102. doi:10.1053/j.gastro.2007.03.052
- O'Loughlin, J., Ledoux, J., Barnett, T., & Paradis, G. (1996). La commande du coeur ("shop for your heart"): A point-of-choice nutrition education campaign in a low-income urban neighborhood. *American Journal of Health Promotion : AJHP*, *10*(3), 175-178.
- Osler, M., Heitmann, B. L., Hoidrup, S., Jorgensen, L. M., & Schroll, M. (2001). Food intake patterns, self rated health and mortality in Danish men and women. A prospective observational study. *Journal of Epidemiology and Community Health*, *55*(6), 399-403.
- Paine-Andrews, A., Francisco, V. T., Fawcett, S. B., Johnston, J., & Coen, S. (1996). Health marketing in the supermarket: Using prompting, product sampling, and price reduction to increase customer purchases of lower-fat items. *Health Marketing Quarterly*, *14*(2), 85-99.
- Patterson, R. E., Haines, P. S., & Popkin, B. M. (1994). Diet quality index: Capturing a multidimensional behavior. *Journal of the American Dietetic Association*, *94*(1), 57-64.
- Pettee, K. K., Ham, S. A., Macera, C. A., & Ainsworth, B. E. (2009). The reliability of a survey question on television viewing and associations with health risk factors in US adults. *Obesity (Silver Spring, Md.)*, *17*(3), 487-493. doi:10.1038/oby.2008.554
- Rodgers, A. B., Kessler, L. G., Portnoy, B., Potosky, A. L., Patterson, B., Tenney, J., Thompson, F. E., Krebs-Smith, S. M., Breen, N., & Mathews, O. (1994). "Eat for health": A supermarket intervention for nutrition and cancer risk reduction. *American Journal of Public Health*, *84*(1), 72-76.
- Roos, E., Prattala, R., Lahelma, E., Kleemola, P., & Pietinen, P. (1996). Modern and healthy?: Socioeconomic differences in the quality of diet. *European Journal of Clinical Nutrition*, *50*(11), 753-760.
- Roubenoff, R., Kehayias, J. J., Dawson-Hughes, B., & Heymsfield, S. B. (1993). Use of dual-energy x-ray absorptiometry in body-composition studies: Not yet a "gold standard". *The American Journal of Clinical Nutrition*, *58*(5), 589-591.
- Sallis, J.F., & Owen, N. (2002). Ecological models of health behavior. In: Glanz K, Lewis FM, Rimer BK, (Eds). Health behavior and health education: theory, research, and practice. Third ed. San Francisco, CA: Jossey-Bass. pp. 462-84.

- Seymour, J. D., Calle, E. E., Flagg, E. W., Coates, R. J., Ford, E. S., Thun, M. J., & American Cancer Society. (2003). Diet quality index as a predictor of short-term mortality in the American cancer society cancer prevention study II nutrition cohort. *American Journal of Epidemiology*, *157*(11), 980-988.
- Seymour, J. D., Yaroch, A. L., Serdula, M., Blanck, H. M., & Khan, L. K. (2004). Impact of nutrition environmental interventions on point-of-purchase behavior in adults: A review. *Preventive Medicine*, *39 Suppl 2*, S108-36.
doi:10.1016/j.ypmed.2004.04.002
- Stamatakis, E., Hirani, V., & Rennie, K. (2009). Moderate-to-vigorous physical activity and sedentary behaviours in relation to body mass index-defined and waist circumference-defined obesity. *The British Journal of Nutrition*, *101*(5), 765-773.
doi:10.1017/S0007114508035939
- Stokols, D. (1992). Establishing and maintaining healthy environments. Toward a social ecology of health promotion. *The American Psychologist*, *47*(1), 6-22.
- Stroebele, N., & de Castro, J. M. (2004). Television viewing is associated with an increase in meal frequency in humans. *Appetite*, *42*(1), 111-113.
doi:10.1016/j.appet.2003.09.001
- Stroebele, N., de Castro, J. M., Stuht, J., Catenacci, V., Wyatt, H. R., & Hill, J. O. (2009). A small-changes approach reduces energy intake in free-living humans. *Journal of the American College of Nutrition*, *28*(1), 63-68.
- Sutherland, L. A., Kaley, L. A., & Fischer, L. (2010). Guiding stars: The effect of a nutrition navigation program on consumer purchases at the supermarket. *The American Journal of Clinical Nutrition*, *91*(4), 1090S-1094S.
doi:10.3945/ajcn.2010.28450C
- Thompson, F. E., Midthune, D., Subar, A. F., McNeel, T., Berrigan, D., & Kipnis, V. (2005). Dietary intake estimates in the National Health Interview survey, 2000: Methodology, results, and interpretation. *Journal of the American Dietetic Association*, *105*(3), 352-63; quiz 487. doi:10.1016/j.jada.2004.12.032
- Thomson, M., Spence, J. C., Raine, K., & Laing, L. (2008). The association of television viewing with snacking behavior and body weight of young adults. *American Journal of Health Promotion : AJHP*, *22*(5), 329-335.
- Thorp, A. A., Healy, G. N., Owen, N., Salmon, J., Ball, K., Shaw, J. E., Zimmet, P. Z., & Dunstan, D. W. (2010). Deleterious associations of sitting time and television viewing time with cardiometabolic risk biomarkers: Australian diabetes, obesity

and lifestyle (AusDiab) study 2004-2005. *Diabetes Care*, 33(2), 327-334.
doi:10.2337/dc09-0493

Trichopoulou, A., Kouris-Blazos, A., Wahlqvist, M. L., Gnardellis, C., Lagiou, P., Polychronopoulos, E., Vassilakou, T., Lipworth, L., & Trichopoulos, D. (1995). Diet and overall survival in elderly people. *BMJ (Clinical Research Ed.)*, 311(7018), 1457-1460.

US Census Bureau. (2006). Nation's population one-third minority. Retrieved October 2, 2008 from the US Census Bureau Official Website: <http://www.census.gov/Press-Release/www/releases/archives/population/006808.html>

US Department of Health and Human Services. (1996). Physical activity and health: a report of the Surgeon General. Atlanta, Georgia: US Department of Health and Human Services, CDC. Retrieved April 13, 2010, from Centers for Disease Control and Prevention Official Website: <http://www.cdc.gov/nccdphp/sgr/index.htm>

US Department of Health and Human Services (USDHHS), & US Department of Agriculture (USDA). (2005). *Dietary guidelines for Americans 2005*. Retrieved March 15, 2008, from the USDHHS Official Website: <http://www.healthierus.gov/dietaryguidelines>.

US Department of Health and Human Services. (2009). Developing Healthy People 2020: Physical activity and fitness. Atlanta, Georgia: US Department of Health and Human Services, CDC. Retrieved December 15, 2010, from the US Department of Health and Human Services Official Website: www.hhs.gov

US Department of Health and Human Services (USDHHS), & Assistant Secretary for Planning and Evaluation (ASPE). (2010). Poverty guidelines, research, and measurement. Retrieved May 1, 2010, from the ASPE Official Website: <http://aspe.hhs.gov/poverty>.

Vermeer, W. M., Steenhuis, I. H., & Seidell, J. C. (2009). From the point-of-purchase perspective: A qualitative study of the feasibility of interventions aimed at portion-size. *Health Policy (Amsterdam, Netherlands)*, 90(1), 73-80.
doi:10.1016/j.healthpol.2008.07.006

Winkleby, M. A., Jatulis, D. E., Frank, E., & Fortmann, S. P. (1992). Socioeconomic status and health: How education, income, and occupation contribute to risk factors for cardiovascular disease. *American Journal of Public Health*, 82(6), 816-820.

- Wirt, A., & Collins, C. E. (2009). Diet quality--what is it and does it matter? *Public Health Nutrition*, 12(12), 2473-2492. doi:10.1017/S136898000900531X
- World Health Organization (WHO). (2001). Turning the tide of malnutrition: responding to the challenge of the 21st century. Retrieved May 25, 2010, from the World Health Organization Official Website: <http://www.who.int/en/>
- WHO. (2006). Obesity and overweight: What are overweight and obesity? Retrieved May 25, 2010, from the World Health Organization Official Website: <http://www.who.int/topics/obesity/en/>
- World Health Organization. (2010). Chronic Diseases and Health Promotion. Retrieved May 1, 2010, from the World Health Organization Official Website: <http://www.who.int/chp/en>.
- Young, B. (2003). Does food advertising influence children's food choices? *International Journal of Advertising*, 22, 441-459.

APPENDIX A

CHAPTER 2 IRB APPROVAL, CONSENT FORM, AND STUDY QUESTIONNAIRES



Research Compliance Office
Office for Research & Sponsored Projects Administration
P.O. Box 873503
Tempe, AZ 85287-3503

Phone
(480) 965-6788
Facsimile
(480) 965-7772

To: Kathleen Woolf
HSC

From: Anna Schwartz, Chair
Bioscience

Date: 10/22/2007

Committee Action: Approval

IRB Action Date 10/22/2007

Approval Date 10/17/2007

IRB Protocol # 0710002209

Study Title The Association Between Activity and Markers of Obesity and Chronic Disease

Expiration Date 10/16/2008

The above-referenced protocol has been APPROVED following Full Board Review by the Institutional Review Board.

This approval does not replace any departmental or other approvals that may be required. It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date noted above. Please allow sufficient time for continued approval. Research activity of any sort may not continue beyond the expiration date without committee approval. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol on the expiration date.

Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study termination.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Bioscience immediately. If necessary a member of the Committee will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Bioscience. The new procedure is not to be initiated until the IRB approval has been given.

**ARIZONA STATE
UNIVERSITY**Research Compliance Office
Office for Research & Sponsored Projects Administration
P.O. Box 873503
Tempe, AZ 85287-3503**Phone**
(480) 965-6788
Facsimile
(480) 965-7772

To: Kathleen Woolf
HSC

From: Anna Schwartz, Chair
Institutional Review Board

Date: 10/31/2007

Committee Action: **Amendment to Approved Protocol**

Approval Date: 10/31/2007

Review Type: Expedited F12

IRB Protocol #: 0710002209

Study Title: The Association Between Activity and Markers of Obesity and Chronic Disease

Expiration Date: 10/16/2008

The amendment to the above-referenced protocol has been APPROVED following Expedited Review by the Institutional Review Board. This approval does not replace any departmental or other approvals that may be required. It is the Principal Investigator's responsibility to obtain review and continued approval of ongoing research before the expiration noted above. Please allow sufficient time for reapproval. Research activity of any sort may not continue beyond the expiration date without committee approval. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol on the expiration date. Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study termination.

This approval by the Institutional Review Board does not replace or supersede any departmental or oversight committee review that may be required by institutional policy.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Institutional Review Board immediately. If necessary a member of the IRB will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Institutional Review Board. The new procedure is not to be initiated until the IRB approval has been given.

Please retain a copy of this letter with your approved protocol.

Kathleen Woolf

From: Rebecca Bliquez
Sent: Wednesday, October 31, 2007 3:28 PM
To: Kathleen Woolf; Brandy-Joe Milliron; Shauna Salvesen; Mallory Adams
Subject: IRB #0710002209, Kathleen Woolf
Attachments: Woolf, 0710002209.pdf

Dear Dr. Woolf,

This is a courtesy notification that the proposed amendments to, "The Association Between Activity..." have been approved.

These amendments included:

- Change in enrollment

A copy of your official approval letter is attached and a copy has been mailed to you.

Please contact me if you have further questions.

Thank you!

Rebecca Bliquez
IRB Coordinator, Sr.
Research Compliance Office
Arizona State University
Admin B, Room 371
(480) 965-4796 (Phone)
(480) 965-7772 (Fax)

Rebecca.Bliquez@asu.edu
<http://researchadmin.asu.edu/compliance/irb/>

Kathleen Woolf

From: Rebecca Bliquez
Sent: Wednesday, October 31, 2007 3:28 PM
To: Kathleen Woolf; Brandy-Joe Milliron; Shauna Salvesen; Mallory Adams
Subject: IRB #0710002209, Kathleen Woolf
Attachments: Woolf, 0710002209.pdf

Dear Dr. Woolf,

This is a courtesy notification that the proposed amendments to, "The Association Between Activity..." have been approved.

These amendments included:

- Change in enrollment

A copy of your official approval letter is attached and a copy has been mailed to you.

Please contact me if you have further questions.

Thank you!

Rebecca Bliquez
IRB Coordinator, Sr.
Research Compliance Office
Arizona State University
Research Admin B, Room 371
(480) 965-4796 (Phone)
(480) 965-7772 (Fax)

Rebecca.Bliquez@asu.edu
<http://researchadmin.asu.edu/compliance/irb/>

Kathleen Woolf

From: Alice Garnett
Sent: Thursday, December 31, 2009 10:58 AM
To: Kathleen Woolf
Cc: Brandy-Joe Milliron; Mallory Adams; Shauna Salvesen; Joshua Eberhard
Subject: re: IRB 0710002209
Attachments: Woolf 0710002209.pdf; Woolf mod.pdf; Woolf consent.pdf

Dear Dr. Kathleen Woolf:

The requested modification to your study "The Association Between Activity and Markers of Obesity and Chronic Disease" has been approved.

Your approved notice and approved modification and stamped consent have been attached to this e-mail.

Happy Holidays,

Alice

Alice Garnett
IRB Coordinator
Office of Research Integrity and Assurance
Interdisciplinary Building B, Room 371
Arizona State University
(90) 727-6526 phone
(90) 965-7772 fax

alice.garnett@asu.edu
<http://researchintegrity.asu.edu/>

Kathleen Woolf

From: Susan Metosky
Sent: Thursday, October 18, 2007 10:56 AM
To: Kathleen Woolf; Shauna Salvesen; Mallory Adams; Mark Johnson; 'brandyjoe@gmail.com'
Subject: The Association Between Activity and Markers of Obesity and Chronic Disease

The Association Between Activity and Markers of Obesity and Chronic Disease
0710002209

Kathleen Woolf, Shauna Salvesen, Mallory Adams, Mark Johnson, and Brandy-Joe Milliron,
The Institutional Review Board reviewed the above-referenced protocol on October 17, 2007. The Board required the following modifications in order for you to secure IRB approval. Please submit the following for review by the IRB. The following revisions are considered minor and can be reviewed by the Chair on behalf of the committee.

Application-Submit a revised application that incorporates the following

- Provide the name of the individual(s) who is administering the DXA. If this will be done by a group of individuals, please provide the name of the group.
- For question 7a, provide an updated start date such as November 15, 2007.
- Add pregnancy test to the screening and verify that all women will be given a pregnancy test in addition to indicating that they are not pregnant.
- Add information about the amount of blood collected in question 20b.

Flyer and Screening forms-Submit revised forms that incorporate the following

- Add DXA.
- Describe when the SEDCO telephone screening form is used (question 10a of the application).
- Verbal Script-describe what "weighed food" is and add DXA.

Please forward the revised materials to the Research Compliance Office as soon as possible. If sending the materials by mail, please make sure to reference the title and address the materials to me. Please feel free to send the documents electronically, if that is easier. An approval letter will be sent to you following the approval of the revisions. Please do not hesitate to contact me if you have any questions.

Sincerely,
Susan

Susan Metosky, MPH
IRB Administrator
Research Compliance Office
Admin B Room 371
Arizona State University
Tempe AZ 85287-1103 (Mail Code 1103)
Telephone: 480 727-0871 Fax: 480 965-7772
Susan.Metosky@asu.edu
<http://researchadmin.asu.edu/compliance/irb/>

Kathleen Woolf

From: Susan Metosky
nt: Monday, September 28, 2009 10:42 AM
To: Kathleen Woolf
Subject: The Association Between Activity and Markers of Obesity and Chronic Disease
Attachments: 0794_001.pdf

Kathleen Woolf,
The continuation of your study "The Association Between Activity and Markers of Obesity and Chronic Disease" has been approved.
Susan

Susan Metosky, MPH
IRB Administrator
Office of Research Integrity and Assurance
Interdisciplinary B Room 371
Arizona State University
Tempe AZ 85287-1103 (Mail Code 1103)
Telephone: 480 727-0871 Fax: 480 965-7772
Susan.Metosky@asu.edu
<http://researchintegrity.asu.edu/humans>

Office of Research Integrity and Assurance

fw

To: Kathleen Woolf
HSC

From: Carol Johnston, Chair *sw*
Bioscience Full Board

Date: 09/28/2009

Committee Action: Renewal

IRB Action Date 09/28/2009

Renewal Date 09/28/2009

IRB Protocol # 0710002209

Study Title The Association Between Activity and Markers of Obesity and Chronic Disease

Expiration Date 09/22/2010

The above-referenced protocol was given renewed approval following full board review by the Bioscience Full Board.

It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date. You may not continue any research activity beyond the expiration date without approval by the Committee. Failure to renew your study before the expiration date will result in termination of the study and suspension of related research grants.

Adverse Reactions: If any untoward incidents or severe reactions should develop as a result of this study, you are required to notify the Bioscience Full Board immediately. If necessary a member of the Committee will be assigned to look into the matter. If the problem is serious, approval may be withdrawn pending IRB review.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, or the investigators, please communicate your requested changes to the Bioscience Full Board. The new procedure is not to be initiated until the IRB approval has been given.

CONSENT FORM

The Association Between Activity and Markers of Obesity and Chronic Disease

INTRODUCTION

The purposes of this form are to provide you (as a prospective research study participant) the information that may affect your decision as to whether or not to participate in this research and to record the consent of those who agree to be involved in the study.

RESEARCHERS

Kathleen Woolf, PhD, RD, Assistant Professor of Nutrition at Arizona State University, Shauna Salvesen, BS, Brandy-Joe Milliron, MS, Mallory Adams, BS, and Joshua Eberhard, students under the direction of Dr. Kathleen Woolf, have invited your participation in a research study. The title of the research project is "The Association Between Activity and Markers of Obesity and Chronic Disease."

STUDY PURPOSE

The purpose of the research is to examine the associations between levels of activity and markers of obesity and chronic disease in normal weight, overweight, and obese women.

DESCRIPTION OF RESEARCH STUDY

If you decide to participate, then as a study participant you will join a study involving research of activity and markers of obesity and chronic disease. The study will involve the following completed in three study visits at ARIZONA STATE UNIVERSITY.

At the first visit:

1. You will have your height, weight, and blood pressure measured.
2. You will be asked to fill out a 7-day weighed-food and beverage record. You will be provided with a food scale and detailed instructions on how to complete this food and beverage record, writing down all foods and beverages you consume over seven days, including two weekend days. You will also report the primary activity completed while food was consumed (i.e. sitting at kitchen table with family, watching television, working at desk or computer). You will spend up to 20 minutes per day filling out the food record.
3. You will be asked to wear a motion sensor during waking hours for seven consecutive days as a quantifiable measure of activity. You will also be asked to record activity you perform. You will be provided with instructions on how to use the motion sensor and how to record the activities that you performed.
4. You will be given a health history questionnaire which includes questions on personal health history, family health history, lifestyle behaviors, and demographics. You will be given an eating behaviors questionnaire. Some questions on these questionnaires may be considered sensitive. You may skip questions on the questionnaires. You will be asked to complete the questionnaires at home.

ASU IRB Approved	
Sign <u>SM</u>	
Date <u>9/20/09 - 9/22/10</u>	

Initials _____
1 of 5

12. I understand that in case of injury, if I have questions regarding my rights as a subject/participant in this research or if I feel I have been placed at risk, I can contact the Chair of Human Subjects Institutional Review Board, through the Office of Human Research Administration, at 480-965-6788.
13. I understand that my study results will not be shared with my doctor or insurance company except with my consent. If I have results to a study that are abnormal, I will be alerted and encouraged to share this information with my physician.
14. I have read the above informed consent. The nature, demands, benefits and any risk of the project have been explained to me. I knowingly assume any risks involved. I understand that I may withdraw my consent and discontinue participation at any time without penalty or loss of benefit to myself. In signing this consent form, I am not waiving any legal claims, right or remedies. A copy of this consent form will be offered to me.

Subject Name (Printed) _____

Subject Signature _____ Date _____

15. I certify that I have explained to the above individual the nature and purpose, the potential benefits and possible risks associated with participation in this research study, have answered any questions that have been raised and have witnessed the above signature.
16. These elements of Informed Consent conform to the assurance given by Arizona State University to the Department of Health & Human Services to protect the rights of human subjects.
17. I have offered the subject/participant a copy of this signed consent document.

Signature of Investigator _____ Date _____

If you say YES, then your participation will last for approximately three hours during the three study visits at Arizona State University. Approximately 200 subjects will be participating in this study.

RISKS

If you decide to participate in this study, then you may face a risk of feeling light-headed or dizzy, experience other mild discomforts, or get a bruise from the blood draw. The researchers have tried to reduce these risks by completing the blood draw in a sitting position and using a tight, pressure band after the blood draw to reduce the possibility of a bruise.

You will also be exposed to radiation during the body composition assessment using DXA. The maximum radiation exposure will be less than 0.10 mrem. The risk of harm from this amount of radiation is very low. This amount is less than the amount of radiation received on a roundtrip plane flight from Los Angeles to New York (about 10 mrem). The dose you will receive is within the radiation safety guidelines of the National Institutes of Health, i.e., 3000 mrem to any tissue in a 13-week period and 5000 mrem in one year. You understand that the effects of low levels of radiation on a fetus are unknown. Therefore, you may not participate if there is any possibility that you might be pregnant.

If you become seriously ill as a result of being in our study, we could refer you to Student Health on the Polytechnic campus or an outside clinic. In an emergency, we would call 911.

And as with any research, there is some possibility that you may be subject to risks that have not yet been identified.

There are no feasible alternative procedures available for this study.

BENEFITS

The possible/main benefits of your participation in the research are:

1. You will obtain information regarding your daily dietary intake.
2. You will obtain information regarding your blood chemistry.
3. You will obtain information regarding your health and nutritional status.
4. You will obtain information regarding your daily activity level.
5. You will obtain information regarding your body composition.
6. You will be providing valuable information about the association between activity and markers of obesity and chronic disease.

NEW INFORMATION

If the researchers find new information during the study that would reasonably change your decision about participating, then they will provide this information to you.

CONFIDENTIALITY

All information obtained in this study is strictly confidential unless disclosure is required by law. The results of this research study may be used in reports, presentations, and publications, but the researchers will not identify you. In order to maintain confidentiality of your records, Dr. Kathleen Woolf, Shauna Salvesen, Brandy-Joe Milliron, Mallory Adams,

Initials _____
3 of 5

and Joshua Eberhard will use code numbers on all of the information collected from you. They will maintain a master list away from the information collected and keep it private. All data will be reported in aggregate form only. No subject will be individually identified, except by code number only known by Dr. Kathleen Woolf, Shauna Salvesen, Brandy-Joe Milliron, Mallory Adams, and Joshua Eberhard.

WITHDRAWAL PRIVILEGE

It is ok for you to say no. Even if you say yes now, you are free to say no later, and withdraw from the study at any time. Your decision will not affect your relationship with Arizona State University or otherwise cause a loss of benefits to which you might otherwise be entitled.

COSTS AND PAYMENT

There is no payment for your participation in the study.

COMPENSATION FOR ILLNESS AND INJURY

If you agree to participate in the study, then your consent does not waive any of your legal rights. However, no funds have been set aside to compensate you in the event of injury. If you are injured as a result of the research procedures, your injury will be treated. Immediate medical care will be available to you at the ASU research facility. Your insurance company may not cover any injuries that you sustain as part of being in this research study, and you may be responsible for any charges. Minor complications as a result of the research procedures while on campus at ASU may be treated at any University Health Center.

VOLUNTARY CONSENT

Any questions you have concerning the research study or your participation in the study, before or after your consent, will be answered by Dr. Kathleen Woolf, Department of Nutrition, Arizona State University, 7001 East Williams Field Road, Mesa, AZ, 85212, 480-727-1705.

If you have questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the Arizona State University Research Compliance Office, at 480-965-6788.

This form explains the nature, demands, benefits and any risk of the project. By signing this form you agree knowingly to assume any risks involved. Remember, your participation is voluntary. You may choose not to participate or to withdraw your consent and discontinue participation at any time without penalty or loss of benefit. In signing this consent form, you are not waiving any legal claims, rights, or remedies. A copy of this consent form will be given to you.

Your signature below indicates that you consent to participate in the above study.

Subject Name (Printed) _____

Subject Signature _____ Date _____

Initials _____
4 of 5

INVESTIGATOR'S STATEMENT

"I certify that I have explained to the above individual the nature and purpose, the potential benefits and possible risks associated with participation in this research study, have answered any questions that have been raised, and have witnessed the above signature. These elements of Informed Consent conform to the Assurance given by Arizona State University to the Office for Human Research Protections to protect the rights of human subjects. I have provided the subject/participant a copy of this signed consent document."

Signature of Investigator: _____ Date _____

Initials _____
5 of 5

APPENDIX B

CHAPTER 3 AND 4 : IRB APPROVAL, CONSENT FORM, AND STUDY
QUESTIONNAIRES

HS LOG NO. _____

APPLICATION FOR THE CONDUCT OF RESEARCH INVOLVING HUMAN SUBJECTS
ARIZONA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD (IRB)

The Arizona State University IRB reviews all requests to conduct research involving human subjects. In completing the following application, be advised that the persons reviewing it may be entirely unfamiliar with the field of study involved. Present the request in **TYPED** form and in nontechnical terms understandable to the IRB. It is the investigator's responsibility to give information about research procedures that is most likely to entail risk but not to express judgment about the risk. Please submit a copy of your complete proposal, an informed consent/assent form as subjects will view it, any other material or background information that will assist the IRB's review, and a curriculum vitae or biographical sketch.

PRINCIPAL INVESTIGATOR	DEPT./CENTER	DATE OF REQUEST
Kathleen Woolf, PhD, RD, Linda Vaughan, PhD, RD, Christine Reese, Maureen Mason, Leah Beard	Department of Nutrition	February 6, 2003
TYPE OF REVIEW:	NEW (X) RENEWAL () If renewal, are there any substantive changes? Yes () No ()	FULL BOARD (X)
EXEMPT: () Number(s) that apply _____	FOR OFFICE USE ONLY	
EXPEDITE: () Number(s) that apply _____		
PROJECT TITLE: <u>Impact of Habitual Physical Activity on Risk of Chronic Disease in Women Throughout the Adult Lifecycle</u>		
AGENCY SUBMITTED TO: ASU East Faculty Grant-in-Aid Program	SUBMISSION DATE: October 30, 2002 FUNDED: January 2003	LOCATION OF PROJECT: ASU East Nutrition Lab
1. GENERAL PURPOSE OF THE RESEARCH: to assess chronic disease risk factors in active and sedentary women at various stages of the adult lifecycle.		
2. DATA OBTAINED BY:	Questionnaire (X) Telephone (X) Interview (X)	
	Observation () Experiment (X) Secondary Source ()	
Other (explain) <u>Blood draw, resting metabolic rate, body composition (bioelectrical impedance, DXA, and anthropometric measures), bone mineral density (DXA), and detailed 7-day food and physical activity records.</u>		

3. PROJECT DESCRIPTION: The IRB must have sufficient information, nontechnical and detailed, about what will happen with/to subjects to evaluate/estimate the risks. Assurance from the investigator, no matter how strong, will not substitute for a description of the transactions between investigator and subject. If a questionnaire is used, attach a copy. (When visual or auditory stimuli, chemical substances, or other measures might affect the health of the subjects, a statement from a qualified person or other appropriate documentation will aid in evaluating the nature of any risk created. In questionable cases, the IRB will require such documentation.)

[Summary of Methodology]

As the proportion of older adults rises in this country, efforts need to be directed toward improving the quality of life. Unfortunately, the prevalence of obesity and overweight is increasing at an alarming rate. Obesity is a risk factor for other chronic diseases, such as diabetes and cardiovascular disease. In addition, many age-related physical changes can increase risk of chronic disease. For women, there are certain life stages where the risk of obesity is highest. For example, the menopause transition is one stage of life characterized by changes in weight and body composition and a greater incidence of obesity-related health conditions.

Research has clearly shown that physical activity protects against certain chronic health conditions. Habitual physical activity is beneficial throughout the lifecycle and may be especially important for older females to decrease adiposity and risk of chronic disease. It is not known whether habitual physical activity can attenuate some of these changes in health that occur as a woman ages. Thus, the purpose of this study is to evaluate chronic disease risk factors in sedentary and active women throughout the lifecycle.

One hundred fifty weight-stable women will be recruited for this study. Subjects will be classified as young (20-30 y) active or sedentary, midlife (40-50 y) active or sedentary, and older (≥ 60 y) active or sedentary. Active women are those that participate in > 6 h/wk of programmed physical activity for ≥ 5 y. Sedentary women will participate in < 2 h/wk of programmed physical activity for ≥ 5 y. Subjects will complete questionnaires to assess health history, eating behaviors, dietary supplement use, and physical activity patterns. Subjects will also be interviewed about medication use (prescription and over-the-counter). Subjects will complete 7-day weighed food and activity records and wear pedometers on seven days to verify their activity status. Body composition (height, weight, body fat, waist circumference, hip circumference), bone mineral density, and resting metabolic rate will be determined for each subject.

Fasting blood samples will be drawn to assess blood markers of health and disease. Insulin, glucose, and lipid status (total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, and triglycerides) will be measured for each subject. C-reactive protein, a measure of inflammation and an independent risk factor for cardiovascular disease, will be determined. Serum thyroid-stimulating hormone, follicle-stimulating hormone, and estradiol concentrations will be determined. Two novel blood markers of obesity, leptin and ghrelin, will also be included in this study.

The dependent variables of this study include the markers of weight gain and chronic disease. Two-way analysis of variance will be used to test for significant differences in the main effects (age and activity) and the interaction of the main effects.

1/02

(Continued)

4. **SUBJECT SELECTION:** Will subjects be less than 18 years of age? Yes () No (X)

How many subjects will participate? 150 Male () Female (X) Age > 20 years

Will subjects be students at Arizona State University? Yes () No (X)

Source: Flyers in public places, ASU Staff Newsletters (Insight), retirement centers, athletic clubs

5. **How** will subjects be selected, enlisted or recruited? Flyers and advertisements in newsletters will be used to recruit volunteers and they will be asked to contact the researchers. Once volunteers call, a verbal script will be read over the phone describing the study.

6. **How** (in writing) will subjects be informed of procedures, intent of the study, and potential risks to them? A complete description of the study will be given verbally to subjects prior to entry into the study. A written description will be provided in the informed consent form.

7. **How** (in writing) will subjects be informed they may withdraw at any time without prejudice? Subjects will be informed verbally as well as in the informed consent form that they may withdraw at any time without prejudice.

8. **How** will subjects' privacy be maintained and confidentiality guaranteed? Subject codes will be used on all data collected. A master list will be maintained separate and secure from data. Results will be published in aggregate form only.

ATTACHMENTS: Please indicate those items we can expect to find as attachments.

Proposal	(X)	Informed consent form (as adult subjects view it) or release form	(X)
Questionnaire/Interview Outline	(X)	Assent form (as child subjects will view it)	()
Cover Letter	()	Curriculum Vitae or Bibliographical Sketch (Faculty ONLY) (Not required for exemptions)	()
Verbal Script	(X)		

Other Documentation Recruitment flyers, diet and physical activity record sheets

In making this application, I certify that I have read and understand the Policies and Procedures for Projects that Involve Human Subjects and that I intend to comply with the letter and spirit of the University Policy. Significant changes in the protocol will be submitted to the IRB for written approval prior to these changes being put into practice. Informed consent/assent records of the subjects will be kept for at least three (3) years after the completion of the research.

SIGNATURES: Principal Investigator (faculty)	Department Chair	Date
<i>Kathleen Wolf</i>	<i>Jude A Vaughan</i>	2-7-03

This application has been reviewed by the Arizona State University IRB:

FULL REVIEW BOARD () EXEMPT () EXPEDITE () CATEGORIES: _____

APPROVED () DEFERRED () DISAPPROVED ()

Project requires review more often than annual () Every _____ months

Comments or modifications/conditions for approval, or reason for disapproval:

SIGNATURE _____ Date _____

Chair of University IRB

Principal Investigator: Woolf/Vaughan/Reese HS #: 06981-03

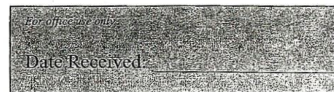
Project Title: Impact of Habitual Physical Activity...

Checklist for Proposals

If any of the following items are checked, the changes described need to be made to the proposal.

1. Modify consent forms to include invitational language such as, "I am requesting your [your child's] participation, which will involve ..."
2. Change any reference to "completing" the task to "filling out" a questionnaire, or "participating" in an interview. Subjects do not have to complete or finish any task, and may withdraw at any time.
3. ** Must complete medical histories/questionnaires*
Include a description of the videotaping/audiotaping procedures in the consent form.
4. Inform the subjects as to the disposition of the videotapes/audiotapes in the consent form. This information should include where the tapes will be kept and for how long.
5. Receipt of applicable translations of forms and documents documenting the method of translation.
6. Add the No Penalty Statement to the consent form, "If you choose not to participate or to withdraw from the study at any time, there will be no penalty. It will not affect your (grade/treatment/care/etc., please choose one which applies to the proposal)"
7. Add the Child Participation No Penalty Statement to the parental consent form, "Your child's participation in this study is voluntary. If you choose not to have your child participate or to withdraw your child from the study at any time, there will be no penalty. It will not affect your child's (grade/treatment/care, etc., please choose one which applies to the proposal). Likewise, if your child chooses not to participate or to withdraw from the study at any time, there will be no penalty."
8. Obtain signatures of the principal investigator and/or department chair on page 2 of the Human Subjects Application.
9. The consent form should be one page, back-to-back, or the subjects should be given a place to initial each page.
10. Remove the asterisk or dotted line between the researcher's name and the consent line on the consent form to ensure that the consent information and signature section remain intact.
11. Add a child assent form to the proposal.
12. Inform the subjects that return of the questionnaire/survey is considered their consent to participate on the information or cover letter.
13. Include the Email Statement on the information letter, "Please note that regular email messages may not be totally confidential because the technology exists that may allow other individuals to intercept and read your email."
14. Include the Web Statement on the information letter, "Please be informed that web-based responses are never completely anonymous. All transactions on the web leave some identifying information such as an IP address or other code from the computer sending the response."
15. Add the Focus Group Statement to the consent form, "Although the researcher is obliged to maintain the confidentiality of the data, other members of the focus group are not bound by that obligation, and thus no guarantee of confidentiality can be made with respect to other subjects in the research."
16. Add the ASU Standard Rights Statement to the consent form, "If you have any questions regarding your [your child's] rights as a research subject, or if you [your child] feel you have been placed at risk, please contact the Chair of the Human Subjects Institutional Review Board, through Karol Householder at (480) 965-6788."
17. Give the subject a place to print his/her name on the consent line.
18. Further clarify the task involved on the child assent form.

Notes: *Removal of DOB from info form?*
Clarification of "disease markers" on verbal scripts, consent forms, fliers... currently very ambiguous



Modification to Protocol to the
Human Subjects Institutional Review Board (IRB)
Arizona State University

PROTOCOL TITLE: Impact of Habitual Physical Activity on Risk of Chronic Disease in Women Throughout the Adult Lifecycle	HS# 06981-03
PRINCIPAL INVESTIGATOR: Kathleen Woolf, PhD, RD	
DEPARTMENT/CENTER: Nutrition	
CO-INVESTIGATOR(S): Linda A. Vaughan, PhD, RD	



Is this modification submitted to fulfill stipulations requested by the IRB? Yes No

Describe the changes you have made to your protocol. Please attach any revised forms or scripts.

In December of 2004, we completed the study "Impact of Habitual Physical Activity on Risk of Chronic Disease in Women Throughout the Adult Lifecycle." The three graduate students that worked on the study have defended their projects and will be graduating in December of 2004. Based upon their work, we have formulated new research questions and would like to repeat the study with a few minor revisions to the original protocol. First, during the blood draw we would like to complete a finger prick to provide a drop of blood to determine blood sugar concentrations. We have noted this information in the informed consent form. Second, we would also like to measure concentrations of adiponectin in the blood. This change has also been noted in the informed consent form. Third, we would like to ask the women about their ethnicity status. We have modified our previously approved health history questionnaire, telephone screening form, and visit one data sheet to include this question. We are including copies of these forms for your review. Fourth, we will be recruiting an additional 150 women to complete this follow-up study (our original IRB application was for 150 women; we had to recruit 209 in order to get the appropriate number of women to finish all the study visits). Finally, we have modified the informed consent form to include the names of the new graduate students that will be working on the study.

PRINCIPAL INVESTIGATOR:	Name (first, middle initial, last): Kathleen Woolf	
	Signature: X <i>Kathleen Woolf</i>	Date: 12-03-04
Please submit to:	Office of Human Research Administration Arizona State University PO Box 873503 (campus mail code 3503) Tempe, Arizona 85287-3503 Fax: 480.965.7772	

Stick ID Label Here

TITLE

INFORMED CONSENT FORM

1. Brandy-Joe Milliron, Kristin Smith, and Gina Cocchiaro, who are students under the direction of Dr. Kathleen Woolf, PhD, RD, Assistant Professor of Nutrition at Arizona State University (ASU) East and Dr. Linda Vaughan, Chair and Professor of Nutrition at ASU, have requested my participation in a research study at this institution. The title of the research project is "Markers of Disease Risk in a Diverse Population of Women."
2. The purpose of the project is to examine markers of chronic disease in a diverse group of women.
3. My participation in the study will involve the following completed study during three visits.
 - a. On my first visit:
 - i. I will have my height, weight, and waist circumference measured.
 - ii. I will have my blood pressure measured.
 - iii. I will fill out a detailed 7-day food and beverage record. I will be provided with a food scale and instructions on how to complete this food record, writing down all the foods and beverages I consume over seven days, including two weekend days.
 - iv. I will wear a step-counter for 7 days and fill out an activity record. I will be provided with instructions on how to use the pedometer and how to record the activities that I complete during each of these seven days.
 - v. I will be briefly interviewed about my medical history and will be given a questionnaire about my health and disease history to be completed at home. I will also fill out an eating behaviors questionnaire.
 - vi. I will be interviewed about my use of dietary supplements, including vitamin and mineral supplements, herbal remedies, and complementary/alternative medicine. I will be interviewed about my use of prescription and over-the-counter medications.
 - vii. This visit will last approximately 1 hour.

I of 4

Initials _____

- b. On my second visit:
- i. I will have my resting metabolic rate (RMR) determined twice in the same morning. I understand that this measurement must be done within five days after onset of menstruation. I am aware I cannot consume caffeine-containing foods or beverages 24 hours prior to this measurement, and that I cannot exercise for two days prior to this measurement. I am aware that I will rest quietly for 20 minutes with a clear hood placed over my head. After the resting period, oxygen uptake will be measured for 20 minutes. This entire procedure will be repeated a second time.
 - ii. I will have 25 mL (approximately one and one-half tablespoons) of blood drawn. Prior to the blood draw, I will fast for 8 hours (nothing to eat since midnight the night before). A trained phlebotomist will complete the blood draw. The blood will be used to measure glucose, insulin, a lipid panel [cholesterol, triglyceride, direct high density lipoprotein (HDL) cholesterol, and direct low density lipoprotein (LDL) cholesterol], adiponectin, thyroid stimulating hormone, leptin, and ghrelin. A light breakfast will be served after the blood draw. The lipid panel will be analyzed by Sonora Quest Laboratories. All other blood samples will be analyzed by the nutrition laboratory at ASU. The blood will be disposed of in biohazard waste after these measurements have been determined. Only the consented tests will be performed.
 - iii. This visit will last approximately 2 hours.
- c. On my third visit:
- i. My body composition and bone mineral density will also be determined by dual energy x-ray absorptiometry (DXA). I will be asked to rest on a table for a period of time between twenty and thirty minutes. I will receive a full body scan with low-intensity x-rays. I cannot consume a calcium containing mineral supplement for eight hours prior to the bone scan.
 - ii. This visit will last approximately 45 minutes.
4. I understand that there are foreseeable risks or discomforts to me if I agree to participate in the study.
- a. I may feel light-headed or dizzy, experience other mild discomforts and get a bruise from the blood draw.
 - b. I may feel uneasiness or mild discomfort during the measurement of my RMR due to the clear hood placed over my head.
 - c. I will be exposed to radiation during the bone mineral density measurement (DXA). The maximum radiation exposure will be up to 10 mrem. This amount is similar to the amount of radiation received on a roundtrip plane flight from Los Angeles to New York (about 10 mrem). The potential long-term risk from these radiation doses is uncertain. However, the dose I will

receive is within the radiation safety guidelines of the National Institutes of Health, i.e., 3000 mrem to any tissue in a 13-week period and 5000 mrem in one year. I understand that the effects of low levels of radiation on a fetus are unknown. Therefore, I may not participate if there is any possibility that I might be pregnant.

5. I understand there are no alternative procedures available.
6. I understand possible benefits of my participation in this study include:
 - a. I will obtain information regarding my daily dietary intake.
 - b. I will obtain information regarding my blood chemistry.
 - c. I will receive information about my health and nutritional status.
 - d. I will obtain information regarding my resting metabolism rate.
 - e. I will obtain information regarding my body composition and bone mineral density.
 - f. I will be providing valuable information about the markers of chronic disease for a diverse group of women.
7. I understand that the results of the research study may be published but that my name or identity will not be revealed. In order to maintain confidentiality of my records, Brandy-Joe Milliron, Kristin Smith, and Gina Cocchiario will use code numbers on all of the information collected from me. They will maintain a master list away from the information collected and keep it private. All data will be reported in aggregate form only. No subject will be individually identified, except by code number only known by Brandy-Joe Milliron, Kristin Smith, and Gina Cocchiario and their research advisors, Dr. Kathleen Woolf and Dr. Linda Vaughan.
8. I understand that in case of injury I can expect to receive the following treatment or care which will be provided at my expense: first aid will be administered and transportation to the nearest hospital will be arranged. I am aware of the fact that in the event of physical illness or injury, facilities and professional care that are available will not be provided free of charge and that monetary compensation for such injuries or illnesses will not be made.
9. I have been informed that I will not be compensated for my participation.
10. I have been informed that any questions I have concerning the research study or my participation in it, before or after my consent, will be answered by Dr. Kathleen Woolf, Department of Nutrition, ASU, 7001 East Williams Field Road, Mesa, AZ 85212, 480-727-1705, or Dr. Linda Vaughan, Department of Nutrition, ASU, 7001 East Williams Field Road, Mesa, AZ 85212, 480-727-1731.
11. I understand that I may be asked to participate in future studies involving women and chronic disease risk factors. I am free to choose whether I want to participate in additional studies.

- 12. I understand that in case of injury, if I have questions regarding my rights as a subject/participant in this research or if I feel I have been placed at risk, I can contact the Chair of Human Subjects Institutional Review Board, through the Office of Human Research Administration, at 480-965-6788.
- 13. I understand that my study results will not be shared with my doctor or insurance company except with my consent. If I have results to a study that are abnormal, I will be alerted and encouraged to share this information with my physician.
- 14. I have read the above informed consent. The nature, demands, benefits and any risk of the project have been explained to me. I knowingly assume any risks involved. I understand that I may withdraw my consent and discontinue participation at any time without penalty or loss of benefit to myself. In signing this consent form, I am not waiving any legal claims, right or remedies. A copy of this consent form will be offered to me.

Subject Name (Printed) _____

Subject Signature _____ Date _____

15. I certify that I have explained to the above individual the nature and purpose, the potential benefits and possible risks associated with participation in this research study, have answered any questions that have been raised and have witnessed the above signature.

16. These elements of Informed Consent conform to the assurance given by Arizona State University to the Department of Health & Human Services to protect the rights of human subjects.

17. I have offered the subject/participant a copy of this signed consent document.

Signature of Investigator _____ Date _____

APPENDIX C

CHAPTER 5 : IRB APPROVAL, CONSENT FORM, AND STUDY QUESTIONNAIRES

Kathleen Woolf

From: Susan Metosky
Sent: Friday, June 26, 2009 2:14 PM
To: Kathleen Woolf; 'b.appelhans@arizona.edu'; Debra Murphy; 'wrtate@email.arizona.edu'
Subject: Pilot Testing of a Brief "Healthy Shopping Intervention"

Wendy Tate,

The protocol "Pilot Testing of a Brief "Healthy Shopping" Intervention" (U of A PI Brad Appelhans) has been given local review and the ASU IRB acknowledges that oversight is deferred to the University of Arizona IRB and Human Protection Program. The ASU IRB understands that UA IRB will provide review, approval, and continuing oversight as required by 45CFRPart46, 21 CFR Parts 50,56, and 812 an in accordance with applicable Federal and State Laws as authorized by the Affiliation Agreement dated May 5, 2008.

Sincerely,
Susan Metosky

Susan Metosky, MPH
IRB Administrator
Office of Research Integrity and Assurance
Interdisciplinary B Room 371
Arizona State University
Tempe AZ 85287-1103 (Mail Code 1103)
Telephone: 480 727-0871 Fax: 480 965-7772
Susan.Metosky@asu.edu
<http://researchintegrity.asu.edu/irb/index.htm>



4868_001.pdf

Office of Research Integrity and Assurance

IRB Affiliations

To: Woolf, Kathleen

Date: 05 / 10 / 2010

From: IRB Affiliations

Expiration Date: 06 / 25 / 2010

Re: Protocol #: 0906004117: Pilot Testing of a Brief "Healthy Shopping Intervention"

This letter serves as a IRB notification reminder by the IRB Affiliations. It is the primary responsibility of the Principal Investigator to ensure that the re-approval status for lapsed protocols is achieved. All protocols must be re-approved annually by the IRB unless shorter intervals have been specified.

Please note that the level of review given to the continuing review process is the same as that of any new protocol. All requests for re-approval must be reviewed at a convened IRB meeting, except for those protocols that meet the criteria for expedited review.

Please submit the following documents at least three weeks prior to the expiration date to allow for full committee review:

- 1) A completed Continuing Review Form.
- 2) Two (2) copies of each consent form(s) used in the study (If data collection is ongoing).

Please note that you can obtain a copy of the Continuing Review Form through our web site:
<http://researchintegrity.asu.edu/humans>.

As of July 1, 2003, all personnel involved in human subjects research must complete the Human Subjects training course. It is the responsibility of the Principal Investigator to make sure all personnel associated with this study have completed the human subjects training course (see the Office of Research Integrity and Assurance website for a link to the NIH training).

It is a violation of Arizona State University policy and federal regulations to continue research activities after the approval period has expired. If the IRB has not reviewed and re-approved this research by its current expiration date, all enrollment, research activities and intervention on previously enrolled subjects must stop. If you believe that the health and welfare of the subjects will be jeopardized if the study treatment is discontinued, you may submit a written request to the IRB to continue treatment activities with currently enrolled subjects.

Your assistance and cooperation in ensuring that the above-mentioned protocol is received for re-approval evaluation at the Office of Research Integrity and Assurance before the lapse date is greatly appreciated.



RESEARCH AND ECONOMIC AFFAIRS

Discovery

Excellence. Access. Impact.

<http://owprea.asu.edu>

To: Kathleen Woolf, Arizona State University
Brad Appelhans, University of Arizona

From: Debra Murphy, Director *DM*
Office of Research Integrity and Assurance

Date: 06/26/09

Committee Action: IRB Acknowledgement University of Arizona

IRB Protocol #: 0906004117

Study Title: Pilot Testing of a Brief "Healthy Shopping" Intervention

The above-referenced protocol has been given local review and the IRB acknowledges that oversight is deferred to the University of Arizona IRB and Human Protection Program. The ASU IRB understands that UA IRB will provide review, approval, and continuing oversight as required by 45CFRPart46, 21 CFR Parts 50,56, and 812 in accordance with applicable Federal and State Laws as authorized by the Affiliation Agreement dated May 5, 2008.

Please let me know if you have any questions.

Office of Research Integrity and Assurance

1120 S. Cady Mall, Interdisciplinary Bldg. B, Room 371 | PO Box 871103 Tempe, AZ 85287-1103 | P 480 965 4796 | F 480 965 7772
<http://researchadmin.asu.edu/compliance>

Shopping Research Survey

Thank you for participating in this shopping research study conducted by researchers at the University of Arizona and Basha's Family of Supermarkets. Please answer the following questions and mail the surveys back in the pre-addressed, postage-paid envelope provided. **We will send you a \$15 gift card that can be used at Basha's Supermarkets if we receive your completed surveys within 2 weeks.** All of your answers will be kept completely confidential.

1. Please provide your age in years: _____

2. What is your gender?

Female

Male

3. What is your marital status?

Single

Married

Living with a partner

Divorced

Separated

Widowed

4. Which category best describes your ethnicity?

Hispanic or Latino

Not Hispanic or Latino

Note: Hispanic/Latino individuals
should also choose a race

5. Which category best describes your race?

American Indian or Alaskan Native

Asian

Black or African-American

Native Hawaiian or other Pacific Islander

White

Multi-racial

Other

6. How many adults (age 18 and older), including yourself, currently live in your home _____

7. How many children (under age 18) currently live in your home? _____

8. What category best describes your education?

Did not complete high school

High school diploma or equivalent (GED)

Some college or some technical school

Completed junior college or technical school

4-year college degree

Masters degree

Doctorate, Law, or Medical degree

9. Which category best describes your total yearly family income, including all working adults in your household?

\$0 - \$9,999

\$10,000 - \$19,999

\$20,000 - \$29,999

\$30,000 - \$39,999

\$40,000 - \$49,999

\$50,000 - \$59,999

\$60,000 - \$69,999

\$70,000 - \$79,999

\$80,000 - \$89,999

\$90,000 - \$99,000

\$100,000 and above

Prefer not to answer/
Don't know

10. How many times **per week** or **per month** do you go shopping for food?

_____ times **per week**

OR

_____ times **per month**

11. You participated in this study at Basha's Supermarket. How many times **per week** or **per month** do you shop for food at other stores, such as Fry's, Circle K, Safeway, or Wal-Mart?

_____ times **per month** **OR**
 _____ times **per week**

12. How many times **per week** or **per month**, do you eat something from a fast food restaurant, such as McDonald's, Burger King, Taco Bell, Pizza Hut, Jack-in-the-Box, or similar places?

_____ times **per month** **OR**
 _____ times **per week**

13. How many times **per week** or **per month**, do you eat something from other sit-down or carry-out restaurants?

_____ times **per month** **OR**
 _____ times **per week**

14. Are you the person who usually does the grocery shopping for your household? YES NO

15. How tall are you? _____ feet _____ inches

16. How much do you weigh? _____ pounds

17. How many times **per week** do you usually drink fruit juices such as orange, grapefruit, or tomato?

_____ times **per week**

18. Not counting juice, how many times **per week** do you eat fruit?

_____ times **per week**

19. Not counting carrots, potatoes, or salad, how many servings of vegetables do you usually eat **per week**? (Example: A serving of vegetables at both lunch and dinner would be two servings.)

_____ servings of vegetables **per week**

20. During this study, we provided you with information about how to buy healthier foods. How _____ useful do you think this information will be for helping you buy healthier foods in the future?

- Not useful
- A little useful
- Somewhat useful
- Very useful
- Extremely useful

21. If healthy shopping programs like this one were *usually* available in your preferred grocery store, how would this affect your choice shop in that store?

- It would make me less likely to shop there in the future
- It would not affect my decision to shop there in the future
- It would make me more likely to shop there in the future

22. Are you currently on a special diet? **YES** **NO**

If YES, what type? (Please check all that apply)

- _____ Weight loss
- _____ Weight gain
- _____ Diabetic
- _____ Vegetarian
- _____ Low salt
- _____ Low fat
- _____ Low carbohydrate
- _____ Low cholesterol
- _____ Special diet for a medical condition (Specify: _____)
- _____ Other (Specify: _____)

Thank you for completing these surveys. Please send them to us in the pre-addressed, postage-paid envelope provided. If we receive your surveys within two weeks, we will mail you a \$15 gift card to use at Basha's.

Write the address to where we should mail your gift card. **Please write clearly.**
